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Plant Science : Agronomy, Plant Pathology, Entomology at South Dakota State University : A Centennial Report

Lyle A. Derscheid

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PLANT SCIENCE

AGRONOMY, PLANT PATHOLOGY, ENTOMOLOGY
at
SOUTH DAKOTA STATE UNIVERSITY



DR. LYLE A. DERSCHEID

PLANT SCIENCE
AGRONOMY, PLANT PATHOLOGY, ENTOMOLOGY
at
SOUTH DAKOTA STATE UNIVERSITY

A CENTENNIAL REPORT

BY

DR. LYLE A. DERSCHEID
PROFESSOR OF PLANT SCIENCE
EXTENSION AGRONOMIST
RETIRED

*Plant Science Department
South Dakota State University
Brookings, S. Dak. 57007*

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December 3, 1980

Dear Dr. Derscheid:

I am so impressed with the completeness of this history. It will be a valuable tool for many people and source of much enjoyment. There are especially bright spots, such as Profiles of People. Everything is important, however. You presented a very complete picture, a very interesting history. You should be very proud.

Thanks much for allowing me to work on this project. I have learned a great deal about Agronomy. I had never undertaken such a large project before. At first the work seemed overwhelming, but it was work I enjoyed. I hope I helped you out.

Should there be anything I can help you with in completing the book and getting it into print, I would be glad to donate more time to the cause. Congratulations on a fine history.

Sincerely,

(Signed)

Sue Ivey

FOREWORD

Soon after Jacquelline Ullery wrote the story "Handful of Seed" in 1978 it was decided that a more complete history of the Agronomy Department should be compiled. It was an era for history--the nation had celebrated its Bicentennial celebration in 1976, the City of Brookings was preparing its Centennial for 1979, South Dakota State was approaching its Centennial celebration of its founding and the Agronomy Department had passed its Diamond anniversary. Also, there were about 20 current and former staff members each with more than 20 years of memories to help make a history accurate and complete. It seemed that it was a "now or never" situation. If a history were not written now, it may never get done.

The report is divided into ten sections. The first section includes a summary of crop breeding activities in the Agronomy Department and an estimate of value of the technology developed by researchers in the department and disseminated by Extension specialists.

In the section "Departmental Development and Growth", four chapters are devoted to the chronological development of the departments of Agronomy, Plant Pathology, Entomology and Plant Science. Individual photos of 66 staff members, including a half dozen plant pathologists and four entomologists are included. The fifth chapter "Profiles of People" includes histories of more than a dozen notable staff members, such as N. E. Hansen, A. N. Hume, J. G. Hutton, E. S. McFadden, W. W. Worzella, U. J. Norgaard, C. J. Franzke and others, who made outstanding contributions in the field of Agronomy.

Since most agronomic activities were affected by the environment and the development of the state, city, College, Agricultural Experiment Station, Cooperative Extension Service and Agriculture Division, a section "Departmental Heritage" was included. The five chapters in the section include little known facts about the development of the state, county and city and a discussion of the physical features, climate and soils which determine the crops that are raised and type of work done by agronomists. In other chapters it is emphasized that the philosophy and function of the Land Grant College are different than those of the other university and colleges of the state. Not only does it conduct resident instruction, but it includes the Agricultural Experiment Station that conducts research; the Cooperative Extension Service that disseminates information obtained from research to the people who can put the information to use; and numerous service groups.

The section "College Facilities " contains the only organized assemblage of photographs of early buildings (several of which no longer exist) as well as histories of these buildings and major land acquisitions. It also contains histories

of the buildings, facilities and equipment used by agronomists as well as rather complete histories of ten major outlying research stations and five mobile research units.

Eleven Chapters in two sections trace the histories of South Dakota crops--their origin, development and gradually increasing yields. The crop management work, performance testing and the evaluation in plant breeding techniques are discussed, and the 84 cultivars developed in South Dakota are listed. Each of eight chapters includes the names of staff members and graduate students that worked with each crop.

A section of four chapters on soil and water research activities includes the names of staff members and graduate students and a report of the work they did on soil management and conservation, soil fertility, irrigation and soil survey as well as the history of the Soil Testing Laboratory and a graphical portrayal of the 40 counties or parts of counties in which soil surveys have been completed and the 23 counties in which surveys are underway. "Seeds and Weeds" is the eighth section. It includes histories of three service groups--State Seed Laboratory that tests farmers seed for quality, the Foundation Seed Stock Division that increases seed of new varieties and distributes it to South Dakota farmers and the Seed Certification Service that conducts a program to maintain varietal purity and high seed quality. Also discussed is the research work done to develop methods of eliminating and preventing reinfestation of noxious weeds and control of annual weeds. The names of staff members and graduate students are listed in each of four chapters.

While seventeen chapters discussed the research done in the Experiment Station, one long chapter in the section--"Teaching and Extension"--summarizes the work done by Extension Agronomy specialists. It includes photographs of 26 of the specialists. Also in this section is a summary of the resident instruction program. It traces the evolution of courses, curricula, majors and graduate programs, and lists about 500 students that obtained B.S. degrees in Agronomy and Plant Pathology.

The last section includes lists of the Experiment Station and departmental publications (665 bulletins, 84 curriculars and 145 pamphlets) pertaining to Agronomy, over 400 Extension publications, and about 200 papers published in scientific journals or given at national or regional meetings by agronomists, plant pathologists or their graduate students.

The 417-page report includes almost 300 photographs in 39 chapters. Most photographs are on file in the Plant Science Department and a copy of the text is kept on disks of the CPT typewriter. Copies of any portion of the manuscript can be obtained by contacting the Plant Science Department, P. O. Box 2207A, SDSU, Brookings, SD 57007.

Lyle A. Derscheid

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SOURCES OF INFORMATION

Over 250 Agricultural Experiment Station publications, 94 College Catalogs, eight histories, two dozen Extension annual reports, news stories and brochures written for three anniversary celebrations in Brookings and two in Sioux Falls, and the writings of numerous individuals served as the sources of information.

The information written by individuals is indicated by placing the writer's name at the beginning of a chapter or section within a chapter or in parenthesis at the end of a single paragraph or sentence.

Other sources are indicated with an abbreviation in parenthesis at the end of a paragraph or sentence within a paragraph as follows:

(Bul)--one of the 164 bulletins listed in Chapter XXXIX

(Cir)--one of the 84 circulars listed in Chapter XXXIX

(Cat)--one of the 94 College Catalogs reviewed

(W)--Chapter VI, written by former Director of Experiment Station J. W. Wilson, in "A History of South Dakota State College 1881-1931" edited by William H. Powers in 1931.

(A)--Chapter VI written by former Director of Extension Service A. E. Anderson, in "A History of South Dakota State College 1881-1931" edited by William H. Powers in 1931.

(JW)--"Half Century of Progress of the South Dakota Crop Improvement Association" written by Jason S. Webster in 1954.

(LAD)--"Seventy Years at South Dakota State College 1884-1954" compiled by Lyle A. Derscheid in 1954.

(S)--"A History of South Dakota State College 1884-1959" written by Charles L. Sewrey in 1959.

(Ext)--"A History of Extension in South Dakota" compiled by Ima Crisman and edited by John Pates for Epsilon Sigma Phi in 1974.

(LL)--"History of South Dakota's Conservation Districts" written by Lenord L. Ladd in 1969.

(K)--"A History of South Dakota State University 1884-1975" written by J. Howard Kramer in 1975.

(17 yrs)--"Seventeen Years--A Report From South Dakota State University" written anonymously in 1975.

(FJ)--Farm Journal, September, 1946.

(MST)--Minneapolis Sunday Tribune, October 26, 1947.

Photographs were obtained from old bulletins, the files of the Audio-Visual Department, Extension Visual Aids, Plant Science Department and the personal files of J. E. Grafius and Lyle A. Derscheid.

ACKNOWLEDGEMENTS

The efforts of many people were required to compile this Centennial report. Their assistance is greatly appreciated. Chronologically their contributions are gratefully acknowledged.



Verna Mae Van Maanen

Verna Mae Van Maanen, head secretary for Extension Agronomy since January 19, 1970, volunteered to type the manuscript. She, with some assistance from co-workers Diane Buehre and Pam Kampen, typed the original draft of most chapters and revisions, prepared copies for chapter reviewers, incorporated the reviewers' contributions for the editor's copy and did the other secretarial work involved with the preparation of this report.

More than three dozen staff members reviewed chapters pertaining to their fields of expertise and made helpful suggestions. Complete chapters were written by former staff member M. D. Rumbaugh, retired staff members G. Semeniuk and R. C. Kinch and current staff member J. G. Ross. Former staff members J. E. Grafius and W. W. Worzella; retirees D. B. Shank and C. M. Nagel; and current staff members P. B. Price, A. O. Lunden, J. J. Bonnemann, P. L. Carson, B. L. Brage and J. G. Ross each wrote a portion of one or more chapters; and R. A. Moore, D. G. Wells, R. J. Walstrom, C. J. Franzke, Ross, Shank, Bonnemann and Lunden each provided historical writings done by others.



Diane Raemish at her CPT typewriter

Vicki Parker, Plant Science Department CPT typewriter operator, prepared the editor's copy and included editor's corrections in a double-spaced copy for most chapters. Her successor, Diane Raemisch, typed the original copy of several long chapters and prepared the final copy for printing.

Susan Kirkvold-Ivey, part-time Agricultural Information Specialist at SDSU, edited about 30 chapters--several on her own time. She discovered several major errors, suggested many clarification improvements and made hundreds of rhetorical corrections.

Ronald Ladegaard, photographer in the Audio-Visual Department at SDSU produced most of the photographs. He reproduced old photographs, made prints for slides and cropped numerous negatives to make prints of the proper size.

The Board of Directors of the South Dakota Crop Improvement Association provided \$1,000 for miscellaneous expenses, including the production of photographs and paying a CPT operator on several holidays and the mailing of reports ordered in advance.

Leon J. Wrage, Extension Agronomy Coordinator, approved the services of the Extension Agronomy secretaries and the xeroxing of copies that went to chapter reviewers and editor.

Dr. D. D. Dearborn, Dean of Agriculture and Biological Sciences, provided funds for some of the editing and Dr. M. L. Horton, Head of the Department of Plant Science, approved the services of the CPT operator and the mailing of letters to solicit funds from agronomy graduates.

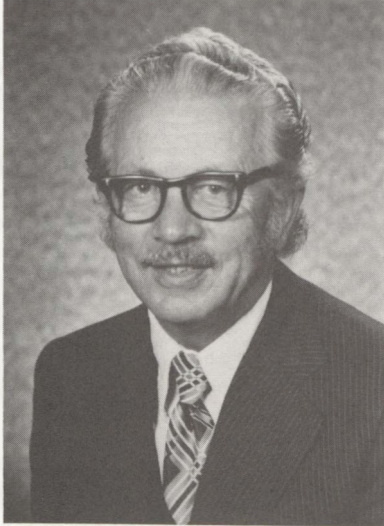
More than 100 former and current staff members and former students contributed funds to help defray the cost of printing.

Chapter Reviewers

Chapter III Dr. W. W. Worzella, Dr. L. O. Fine, Dr. R. A. Moore and Dr. C. R. Krueger
Chapter IV Dr. W. S. Gardner
Chapter V Dr. R. J. Walstrom and Dr. B. McDaniel
Chapter X Dr. R. A. Moore
Chapters XV, XXII & XXVII Dr. F. E. Shubeck, H. A. Geise and Q. S. Kingsley
Chapters XVI Dr. D. B. Shank, Dr. D. E. Kratochvil and Dr. C. M. Nagel
Chapters XVII & XVIII Dr. D. G. Wells, Dr. D. L. Keim and Dr. P. B. Price
Chapter XX Dr. C. L. Lay, Dr. A. O. Lunden and Q. S. Kingsley
Chapter XXII J. J. Bonnemann
Chapters XXIII & XXIV Dr. M. D. Rumbaugh and Dr. J. G. Ross
Chapter XXV Dr. R. A. Moore and Dr. F. R. Vigil
Chapter XXVIII Dr. L. O. Fine and Professor P. L. Carson
Chapter XXXIX Dr. L. O. Fine
Chapter XXX Dr. F. C. Westin, Dr. M. L. Horton and Dr. D. D. Malo
Chapter XXXI Dr. A. O. Lunden
Chapter XXXII J. D. Colburn and R. J. Pollmann
Chapter XXXIII G. W. Erion, J. B. Weber and J. G. Colburn
Chapter XXXVI Dr. D. G. Kenefick and Dr. C. D. Dybing
Chapter XXXVII E. E. Sanderson, R. A. Cline, E. J. Williamson and L. J. Wrage
Chapter XXXVIII Dr. B. L. Brage and Professor Emeritus R. C. Kinch

ABOUT THE AUTHOR

Dr. Lyle A. Derscheid was born and raised in South Dakota, and was associated with the Agronomy Department over a 40-year period as a student, graduate student, weed research project leader, professor of graduate courses and Extension specialist.



Lyle A. Derscheid

The eldest child of August P. Derscheid and Nora E. Leek, he was born December 14, 1916 in the house his maternal grandfather built in 1910 nine miles south of Iroquois on the County Line Farm. The Derscheid family lived in Belle Prairie Township of southeastern

Beadle County for 11 years. Their children, Lyle, Merle, Clinton and DeEtta attended the Dubro school until March 1931 when the family moved to a farm near Wolsey to be near a high school. Lyle was salutatorian in the class of 1935.

The next 3 1/2 years were spent in Civilian Conservation Corp camps at Pierre (where he met LaVonne Gustafson, his future wife), Chamberlain and Presho, South Dakota.

With the aid of a \$90 Sears and Roebuck Scholarship he enrolled in Agronomy at SDSU in September 1939. The following January he started to work in the State Seed Laboratory on the National Youth Assistance Program.

Lyle and LaVonne, whom he nicknamed Bonnie, were married September 8, 1940. Bonnie worked as a secretary. Lyle supervised purity and germination testing in the seed laboratory, was active in student affairs and graduated with high honors in March 1943 with a major in agronomy and minors in botany and animal husbandry.

As an R.O.T.C. graduate he was sent to Officers Candidate School at Fort Knox, Kentucky. He topped the class scholastically and was commissioned a Second Lieutenant in July. He went to Europe with the 12th Armored Division, was wounded in action and spent 13 months in Army hospitals.

On March 16, 1946, he returned to SDSU as a graduate research assistant in weed control. He was appointed to the staff full-time as weed research project leader on July 1, 1947 and obtained an M.S. degree in March 1948 with a major in agronomy and minor in organic chemistry.

He took a leave of absence without pay for five quarters during 1949-50 and 1950-51 to attend graduate school at Iowa State College where he obtained a Ph.D. degree in March 1951 with a joint major in crop production and plant physiology and a minor in crop ecology.

Upon returning to SDSU he continued to devote a major portion of his energy and resources developing methods of controlling noxious weeds and studying the effects of 2,4-D on crops that might be sprayed to selectively control weeds growing in them.

Eight papers were published on the effects of 2,4-D on barley and oats, which gained international prominence for the author. The work was culminated in 1954 when he gave an invitational paper in the physiology section of VIII Congress of Botany, held in Paris, France and attended by representatives from 60 countries.

Five weed research farms were each operated for 5 to 10 years to develop methods of eliminating noxious weeds while growing crops adapted to South Dakota. Six scientific papers discussed the use of cultivation, competitive crops and chemicals for eliminating field bindweed, Canada thistle, perennial sowthistle, leafy spurge and Russian knapweed. Derscheid became nationally known for this work as was recognized by many in the North Central States and Prairie Provinces as a leading authority on these weeds.

Derscheid also supervised the work done by a dozen graduate students that showed (1) how to apply herbicides by airplane, (2) what environmental factors caused thistle seeds to germinate, (3) the stages of growth when seeds of thistles and leafy spurge become viable, (4) the need for insects to cross pollinate thistles, (5) the need for rainfall to activate certain herbicides applied pre-emergence for annual weed control, (6) the morphological development of buds on underground parts of leafy spurge, and (7) the location and stage of growth when the buds developed and the number of such buds.

In the North Central Weed Control Conference he served as chairman of six different committees, was a member of the board of directors for several years and served as presi-

dent in 1958. He was a charter member and director of the Weed Science Society of America and served a year as assistant editor of Weeds. He was twice program chairman and once chairman of the Weeds Division of the American Society of Agronomy.

He taught graduate courses in Advanced Weed Control and Research Methods in Agronomy on alternate years from 1956 to 1962.

During the 1950s and early 1960s he was active in almost every phase of the state weed program and was "Mr. Weeds" to many South Dakota weed fighters.

From the outset of his professional career, he was Extension oriented. Much of his research was problem solving in nature, he wrote many Extension-type publications and participated in numerous educational activities. In 1960 he was asked to be Extension Agronomist. One March 1 he accepted the position on a half-time basis as project leader. He coordinated the programs of Extension specialists in crops, soils and weeds and was Extension liaison with federal agencies.

He retained leadership on the weed research project until June 30, 1964, when he became full-time Extension Agronomist. He then developed a comprehensive pasture program and later took charge of the Extension forage crop program. In the program "Graze Green Grass for Greater Gains", he promoted the use of alfalfa in a pasture mixture either by inter-seeding it in a native pasture or mixing it with cool-season grasses for new seedings of tame pastures. The program also advocated the use of rotational grazing of several pastures--each composed of species that were most productive during a certain period of the grazing season--during the period that they were most productive.

He promoted the use of small grains for forage for areas west of a line from Clear Lake to Lake Andes because pounds of protein and TDN could be produced cheaper with oats than any other crop except for protein by alfalfa.

In 1973 when acreage restrictions imposed on wheat and feed grains by the federal farm

programs were removed and ranchers started to plow native range for wheat production, Derscheid started an inter agency program of "Production without Destruction" in an attempt to prevent undue abuse of natural resources.

At the same time costs of crop production were rising rapidly. He initiated the program "Production for Market Price" in which farmers were urged to compare probable market price per bushel with the costs of production for a bushel and to raise crops that promised to give the most profit per bushel.

In 1976 he was the Extension coordinator for locating hay and/or pasture for the cattle in drought-stricken areas of the state which helped livestock producers find 750,000 tons of hay and pas-ture or wintering facilities for more than 150,000 head of cattle.

As an Extension specialist he wrote the original copy of five Extension circulars, eight Extension mimeographed circulars and almost 60 fact sheets. Many of the publications were revised one or more times and given different numbers.

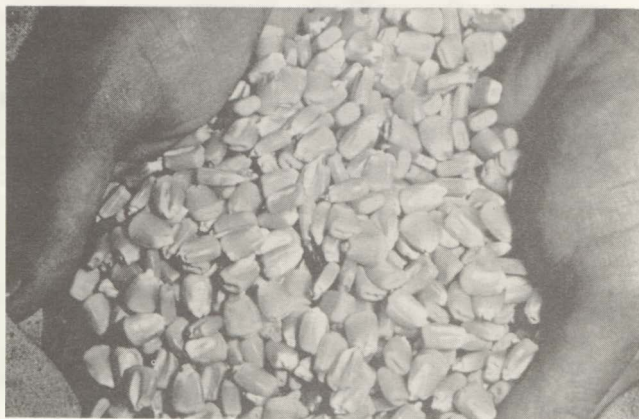
Lyle received several awards over the years--honorary member from both the North Central Weed Control Conference and South Dakota Seed Trade Association, Merit Award from the American Forage and Grassland Council, Distinguished Alumnus award from the SDSU Alumni Association, Outstanding Extension Specialist award from the SD Association of Extension Specialists and plaques expressing their appreciation from the Soil Conservation Service, South Dakota Association of County Weed Boards and the South Dakota Aviation Trades Association.

As chairman of a faculty group composed of SDSC alumni, he edited a short history of the college in 1954. Five years later he was a member of an 11-man committee for the SDSC Diamond Anniversary that planned the events--one of which was the history written by C. L. Sewrey.

Since that time he has collected bits of history about the College and the Agronomy Department. After he retired from the Cooperative Extension Service on July 15, 1979, he spent two and a half years compiling this report.

CHAPTER I HANDFUL OF SEED

All plants have their beginning from "seed" of one form or another. Quality seed of a crop and variety adapted to the soil and climatic conditions is the first link in the chain of crop production practices needed to secure profitable crop yields.



Following is part of a story that appeared in the Fall 1978 issue of *Farm and Home Research*. It was entitled "Handful of Seed" and written by Jacqueline Ullery, who was Assistant Information Specialist in the Agricultural Information Service at SDSU. The story is a historical summary of work done by plant breeders in the Plant Science Department at South Dakota State University. It is the beginning of this story because adapted crop varieties are the foundation of most agricultural endeavors.

Jacquelline Ullery

"This grass variety revolutionized grazing in South Dakota."

"This wheat variety helped come to the rescue when stem rust wiped out whole wheat fields."

"This sorghum seed is one of the first varieties in the U.S. that farmers can plant and not worry about prussic acid poisoning of livestock."

Lyle A. Derscheid, SDSU Extension agronomist, was pointing to different bottles of seed in a collection mounted on the wall in the Plant Science Department at SDSU.

The display consists of rows of 187 2-inch glass bottles, each filled with a different crop seed variety. Each bears a white label identifying the seed and year it was first used on South Dakota farms. The collection appears so simple that it probably draws little attention.

Each of those bottles has contributed its

chapter in the South Dakota story, however. Some 117 bottles contain seed of crop varieties developed in other states and released for use by South Dakota farmers. The seed in 70 other bottles tell of our state, its drought and disease epidemics, and of the men who overcame them.

Some of these varieties bear the stamp of Dakota--Nakota oats, 1939; Vikota oats, 1943; and Manchukota soybeans, 1945. Others have a number-one ring to their names--Primus barley, 1967; Ace barley, 1912; and Winner sorghum, 1964.

Several were named for people. Cole oats was named for John S. Cole, the first Agronomist at SDSC; Fowlds Hulless oats, 1925, named for its developer who was the first seed analyst; and Hume winter wheat was named for A. N. Hume, the first Head of Agronomy.

Still others were named for places (in areas of best adaptation)--Pierre rye, 1950; Waubay oats, 1954; Dupree oats, 1954; Ortleigh oats, 1963.

In 1977 a spring wheat variety was released and named for the town of Eureka, which was the world's largest wheat market from 1887-1902. Eureka means "I have found it."

Alfalfas Are Immigrants

James G. Ross, who has been doing plant breeding at the station for some 30 years, recalled that N. E. Hansen had collected seed of several crops in Russia during the early 1900s. He gave little handfuls of seed to anyone he could get to raise more alfalfa.

In 1948 Ross and M. W. Adams took a trip to western South Dakota after reading accounts of what Hansen had done with some of this alfalfa.

"We'd come across a rolling horizon and here would be a patch of the wild yellow alfalfa that Hansen initiated 30 to 35 years before," Ross says.

Adams also found this yellow-flowered alfalfa growing on the SDSU campus. The area had been mowed and/or used as a golf course from approximately 1914 to 1948, a treatment similar to pasturing. There Adams identified hybrids from the Turkestan and Semipalatinsk alfalfas, which Hansen had brought here from Russian Turkestan and Siberia.

Adams and Ross worked with these varieties and in 1958 released Teton, named for a tribe of the Sioux Nation in the Dakotas.

Semipalatinsk is also in the ancestry of Travois, released in 1963. It is a unique plant with an underground creeping rooted growth. Hence, it received its name from the travois, a horse-drawn carrier used by Indians for travel.

Summer switchgrass, released in 1965, also brought new blood into South Dakota agriculture. Ross developed this warm-season grass to be ready for grazing about July 4th when other grasses begin to go dormant. It along with Teton, Travois and Oahe are seeds Derscheid referred to as revolutionizing grazing in the state.

Wheat Story Started Early

How Hope wheat, 1928, got its name is obvious. It and the H44 selection were the original sources behind resistance to stem rust in all spring wheats today. (They were developed by E. S. McFadden.)

Hume wheat was in the process when Darrell Wells, wheat breeder, came to SDSU in 1962--but that was also the same year for a more than \$25 million loss in South Dakota to a winter wheat rust epidemic. Wells finished the work for releasing Hume wheat in 1965.

He explains its background this way:

"Hume winter wheat is the first winter wheat developed and released in South Dakota. Hume's resistance to stem rust traces back to the pioneering work of E. S. McFadden who worked at the station from 1915 to 1920. McFadden was told the crosses would not work but he made them anyway in his landlady's garden when he was a student.

"Hume was developed from crosses made in 1945 by J. E. Grafius, and further chosen from among surviving lines in 1958 by V. A. Dirks."

Then Wells completed the work for verification of Hume's good qualities, purification, and increase. When Hume was released to growers in 1965, it was named for A. N. Hume, who was the first head of the SDSU agronomy department and had that position for 32 years.

"Break Through" With Sorghum

C. J. Franzke developed 30-39-S sorghum which was released in 1939 and Rancher in 1945. Out of 218 varieties of sorghum available in South Dakota now, only those two varieties can be fed during droughty years without worry about prussic acid poisoning to livestock.

Franzke also worked with the development of Norghum sorghum, which was the first variety



with an open head. It offered the advantage of drying better for harvest. It was also better to combine because it was short and the head extended above the leaves.

Seed Distribution

Once a breeder has seed ready to begin releasing procedures, what happens? In the early 1900s, releasing a seed meant that perhaps 10 seeds or maybe a handful was given to whomever could be talked into growing them. But over the years, crops became bigger business and better methods were needed.

A group of farmers banded together to form the state's Crop Improvement Association. They developed better systems of multiplying new seed quantity. And the business grew.

Corn More Complicated Lyle A. Derscheid

Producing hybrid corn was complicated, and farmers could not produce the amount of seed needed. In the 1930s C. J. Franzke produced several corn inbreds from open-pollinated varieties adapted to South Dakota. Inbreds were crossed to form a single cross. Two single crosses were crossed to produce a double-cross hybrid. Farmers planted this double-crossed seed which was adapted to areas farther north and west than any other hybrids available.

Some individual Crop Improvement members planted and attempted to produce single cross seed. Other farmers and several chapters of the Future Farmers of America planted the single crosses to produce seed for farmers to plant.

Individual producers and FFA chapters did not have facilities for processing the seed or selling it. Since none of the hybrid corn companies in existence at that time were interested in producing the seed, several farmers banded together and formed

Sokota Hybrid Producers Cooperative, a company that had a bushel basket, a desk, a typewriter and a corn grader and dryer in 1945. Now it has its own plant breeders that develop hybrids adapted to South Dakota and adjacent areas. In 1978 it processed over 350,000 bushels and sold over 140,000 bushels of seed.

Sokota, like other commercial corn companies, still secures seed of corn inbreds, developed by scientists at South Dakota and other state Agricultural Experiment Stations, from the Foundation Seed Stock Division at SDSU.

Corn seed produced by Sokota and seed by newly released varieties of all other crops is produced under standards set by the Seed Certification Service. This organization is a division of South Dakota Crop Improvement Association with its office on the SDSU campus. It supervises the production of seed in order to build and maintain a supply of high quality seed for South Dakota farmers.

Results are Beneficial
Jacqueline Ullery

Plant breeders are searchers. They are in touch with the world seed banks and plant

breeders in neighboring states and around the world. When they find a seed that looks suitable for South Dakota, they share samples of it with scientists in other states, test it, and study it further. They work with disease and insect specialists, field men, water specialists, commercial chemical companies, agricultural engineers, and farmers.

Cooperative Extension Service personnel like Derscheid spread the word about new varieties and other information obtained by researchers. "We have tangible results of how we've helped agriculture in South Dakota," Derscheid says.

"Take 1934 which was an extremely dry year. In 1934, farmers were wiped out with at most 7 bushels of oats per acre.

"Then in 1976 similar or even slightly worse weather conditions developed. South Dakota farmers used the newest varieties and combined them with good fertilization, weed control and other improved crop management practices--many of which were developed by SDSU scientists and publicized by extension specialists. Crop yields were not good, but they were four and five times higher than in 1934 and we can see a more stabilized agriculture in South Dakota than ever before."



First 3 buildings at Dakota Agricultural College
North (1887); Central (1884); South (1885)



Woodbine Cottage (1896), Wenona Hall (1909)
(Photo from Central in 1914)

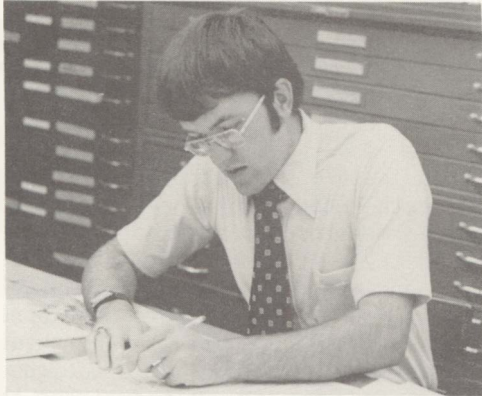


Agricultural Building (1889). Armory-Gymnasium (1889) (Photo from Central in 1914)

CHAPTER II OUR BEST RELEASE

What have Agronomists, Pathologists and Entomologists done for the state? Members of the research staff in the Plant Science Department developed some of the technology and Extension specialists relayed the information to crop producers.

D. D. Malo, soil scientist, completed a study in 1978 that takes a close look at the effects of the advances in farm technology in South Dakota.



TECHNOLOGY - TOP CROP
D. D. Malo

Every so often, we at the South Dakota Agricultural Experiment Station evaluate where we've been and where we're going. One of the ways we can do this is by examining how agricultural technology has improved crop yields in the state.

Numerous factors influence crop production—our climate, for one. Severe droughts occurred in the 1930s and 1970s. However, with improved agricultural technology the drought effect on crop yields was less in the 1970s.

Other factors have affected the way we use our land. Drought, government programs, new hybrids and varieties, fluctuating market demands, changing management, and other technological advancements have all played a part in the agricultural picture.

This study examined the effects of rainfall, temperature, and improved technology on annual crop production and land use in South Dakota. Data from 1919 to 1977 were used.

Crop yields were related to state averages of annual rainfall and temperatures. The crops were corn, barley, oats, rye, wheats, flax, soybeans, grain sorghum, and various hays. Crop and hay yield data represented average yield per harvested acre and were obtained from the USDA Crop Reporting Service.

Climatic data for 1919 through 1977 were obtained from the U.S. Department of Commerce and the Agricultural Engineering Department at SDSU. Average annual precipitation and temperature came from weather station data in the state for each year.

Technology Boosted Yields, Especially in Dry Years

Since 1920, technological advances such as improved varieties, pest control, and better soil-water-fertility management have increased average crop yields. The suggested influence of technology on crop yields at three moisture levels is shown in the Table.

Percent yield increases varied on all crops, but went as high as 329%. The years chosen for comparison had similar average annual precipitation, similar annual temperatures and a similar year preceding it. So, the differences shown are primarily caused by technology and not by climate.

From 1920 to 1977 (wet years) the greatest yield increases occurred in grain sorghum (40 bu/A) and corn (35 bu/A). Alfalfa hay had the least yield improvement during this period.

New technology from research and industry have increased yields more than all moisture and temperature levels considered. The greatest per centage yield increases were noted during drought years. Low wheat and hay yields in 1977 were caused in part by a lack of stored soil moisture from the 1976 drought. Most of the precipitation in 1977 came during the later part of the growing season (July through September). Crops such as wheat and hay which depend on early season precipitation did not benefit from the precipitation, while late season crops such as corn and sorghum did.

The high percentage yield increases in the Dry Years category in the table (1934 versus 1976) were from improved drought tolerance, higher yield potentials, and disease resistance in our varieties; better pest management; improved soil and water management; and because farmers tended to plant for an average precipitation year in 1976.

Technology Helped Change the Look of Rural South Dakota

During the 1930s the drought caused a drastic cut in the amount of land used for corn, hay, oats, durum wheat, spring wheat, and flax. However, the amount of land used for rye and sorghum increased and peaked in 1940 and 1941.

Influence of technology on state average crop yields during wet, dry, and average years.

Year	Wet Years			Average Years			Dry Years		
	1920	1977		1922	1971		1934	1976	
Avg ann precip(in)	27.4	26.1		21.6	21.2		13.3	12.9	
Avg ann temp (°F)	45.1	46.4		45.1	44.9		49.6	47.1	
Crop	Bu/A		% yield Increase	Bu/A		% yield Increase	Bu/A		% yield Increase
Corn	30.0	59.0	97	28.5	46.0	61	10.9	31.0	184
Oats	33.0	54.0	64	30.5	54.0	77	9.6	30.0	213
Barley	22.0	42.0	91	20.0	41.0	105	8.3	17.0	105
Rye	13.5	29.0	115	18.0	35.0	94	3.5	15.0	329
Flaxseed	9.5	13.0	37	9.0	13.0	44	2.5	5.0	200
Sorghum	16.0+	51.0	219	10.4++	35.0	232	6.8	23.0	238
Winter wheat	15.0	25.0	66	18.0	36.0	100	4.5	18.0	300
Durum wheat	12.4	24.0	94	15.5	31.0	100	4.0	10.0	150
Other spring wheat	8.1	23.5	190	12.3	28.0	128	4.8	11.0	129
	T/A			T/A			T/A		
Alfalfa hay	1.45	1.55	7	1.60	1.65	3	0.74	0.80	8
All hay	0.98	1.28	31	0.89	1.28	44	0.50	0.66	32

From 1950 to 1970 the number of acres of barley dropped 75% with the adoption of the Federal Feed Grain Program. Farmers realized more profit from corn than barley; consequently, the corn land use remained fairly constant. At the same time the amount of land used for oats production increased more than 200%. Spring wheat land use declined because of the federal Wheat Stabilization Program and because winter wheat land increased.

From 1948 to 1957 the amount of alfalfa increased more than five times while barley, rye, and grain sorghum declined rapidly. In the late 1940s and early 1950s Ranger and Vernal alfalfa varieties were introduced in the state. These types of alfalfa were very winter hardy and wilt resistant and produced large amounts of forage. Thus, alfalfa became a more favorable crop for farm use. The federal Soil Bank Program and SDSU's all-out program to increase alfalfa and grass acreage for livestock production during the 1960s helped to increase alfalfa acreage.

The amount of land used for flax has diminished since 1954. A few of the reasons are price or market problems and competition from sunflowers. When the price of linseed oil was too high, users turned to other oils--especially soybean and sunflower oils.

Since the advent of soybeans in South

Dakota in the late 1930s, soybean acreage has increased--probably at the expense of corn since both have similar climatic needs.

Rye land use reached its peak in 1939 and declined since then. Durum wheat declined significantly since 1930. The market tended to be poor with a carryover of durum most years, and many acres formerly planted to durum are now used to raise winter wheat.

Technology Reduced Land Abandonment Donald L. Keim

Over the years, improved technology developed by researchers was disseminated through the Extension Service. More crop producers used good quality seed of adapted disease-resistant varieties, improved crop production, soil management and fertility practices, and better weed and insect control techniques.

Though the drought of 1976 was more severe than that 1934, crop yields were greater and a higher percentage of the planted acreage was harvested.

In 1934 75% of the winter wheat acreage was abandoned compared to 18% in 1976. Similar comparisons for the 2 years show 88% and 27% abandonment for spring wheat, 74% and 40% for barley; 58% and 15% for flax; and 84% and 40% for rye.

CHAPTER III AGRONOMY 1884-1969

The Department of Plant Science was formed July 1, 1969 by combining the Departments of Agronomy and Plant Pathology. Ten years later the Department of Entomology--Zoology was abolished and the Entomologists were transferred to the Plant Science Department.

Resident instruction in agronomic subjects was implicit in the first agricultural curriculum of the college (S-43). Agronomic crops were planted in 1888, the first spring after the Agricultural Experiment Station was established. Research actually began when the first agronomic experiment was initiated in 1897 (W-83). The Department of Geology-Agronomy was listed in the college catalog for 1897-1998 (K-43) and the Agronomy Department was formed in 1903 (Cir 123). An Extension specialist was employed in 1920 and statewide services were added in 1921.

HEADS OF AGRONOMY

Clifford Willis was Chief in Agronomy from 1908 to November of 1911 and three men served as Head of the Agronomy Department over the next 58 years.

Dr. Albert Nash Hume	7/1/1911-9/30/1943
Dr. Wallace W. Worzella	10/1/1943-1/10-1958
Dr. Lawrence O. Fine	7/1/1958-6/30/1969

Dr. Frederick C. Westin was acting Head from August, 1966 to February 1967 when Fine was on sabbatical leave.

The number of Extension Agronomists increased from one in 1920 to two in 1936, four in 1945, five in 1948, six in 1949 and remained at that number for 20 years.

EMERGENCE OF AGRONOMY 1887-1910

Resident instruction, one of the four major activities of the college, was conducted in Agronomy from the beginning of the institution in 1884. Research, the second of the major activities, was initiated in a superficial manner in 1888 and put on a scientific basis in 1897.

AGRONOMY EXTENSION LEADERS

Though closely associated with the Agronomy Department, two Extension Agronomists were administratively responsible to the Director of Extension for a half century. Extension Agronomists supervised the work of Assistant and Associate Agronomists. An Extension Weed Specialist was added to the group July 1, 1947.

Three Extension Soils Specialists also were administratively responsible to the Director of Extension and supervised the work of Assistant and Associate Soils Specialists.

In 1960 the Extension Soils Specialists also came under the supervision of the Extension Agronomist.

The Extension leaders with the dates and area of responsibility (A-Agronomy, C-Crops, and S-Soils) were:

Ralph E. Johnston	9/1/1920-6/30/1938-A
U. J. Norgaard,	2/16/1939-8/31/1958-C
Ralph E. Hansen,	11/10/1939-4/30/1944-S
Leonard L. Ladd,	7/1/1944-9/30/1956-S
Edward J. Williamson,	5/1/1957-6/30/1960-S
Dr. Lyle A. Derscheid,	3/1/1960-7/15/1979-A

STAFF

While a college senior, John S. Cole was named special agent with USDA for variety performance testing in 1901. He graduated in 1903 and became Assistant in Agronomy in 1906 and Assistant Agronomist in 1908. Clifford Willis was Chief in Agronomy from 1908 to 1911. There were two Assistant Agronomists in 1909 and three in 1910. In addition, Assistant Agronomists were located at each of the three substations: Highmore, Cottonwood, and Eureka, in 1909.

In 1973 E. W. Hardies listed seven staff members who were in the department when he joined the agronomy staff in 1923. They were A. N. Hume, J. G. Hutton, A. L. Bushey, Mathew Fowlds, C. J. Franzke, L. F. Puhr and himself. Though he included Leo F. Puhr as assistant soils analyst, department records indicate that Puhr did not receive a staff appointment until 1927.

John E. Grafius remembers six full-time professional staff members (Hume, Franzke, Puhr, Edgar Joy, E. L. Erickson and himself) when he joined the department in 1941. E. R. Hehn and Ralph Arms were graduate students in the department.

From 1943 to 1958 the number of staff members increased rapidly. New members of the department included more plant breeders, plant physiologists, soil surveyors, soil fertility personnel, a weed researcher, a soil physicist, and a full-time teacher.

Tenured teaching and research staff members in the department numbered 26 when Dr. W. W. Worzella left in January of 1958. There were seven non-tenured Assistants in Agronomy in 1958 for a total of 33 staff members.

Research Staff

The following names of individuals who contributed to the areas of field crops, soils and weed control were taken from Experiment Station Bulletins. Any teachers who did not have research appointments are not included.

James H. Shepard	1886-1918	Chemist
Luther Foster	1886-1992	Supt. of Agriculture
John M. Aldrich	1888-1891	Entomologist
E. C. Chilcott	2/93-6/30/05	Agriculturist
Dr. Niels E. Hansen	1895-1937	Horticulturist
Thomas A. Williams	1891-1896	Botanist
DeAlton Saunders	1896-10/03	Botanist
W. A. Wheeler	1904-1907	Botanist
Dr. E. W. Olive	1907-1912	Botanist
John S. Cole	1901-1908	Agronomist
Clifford Willis	1908-11/1911	Agronomist
W. D. Griggs	1909-?	Agronomist-Eureka
P. H. Moore	1909-1910	Agronomist (Highmore)
Sam Garver	1909-?	Agronomist (Cottonwood)
Manley Champlin	1909-1911	USDA (Highmore)
J. V. Bopp	1909-1910	Agronomist
H. J. Belsey	1909-1911	Agronomist
H. B. Porter	1910-1911	Agronomist
O. E. White	1910-1911	Botanist
Howard Loomis	1910-1920	Agronomist
W. L. Burlison	1911-1911	Agronomist

From 1959 to 1969 staff size in Agronomy decreased to 27--24 with professional rank and three assistants.

Research Activities

Shortly after the Agricultural Experiment Station was established in 1887, experiments were conducted in raising corn, wheat, oats, barley, potatoes, clover, sugar beets, mangels and millet (W-83).

An old field book entitled the "Experimental field No. 1 comprising 66 plots of grasses and grains--each plot containing 1/8 acre," shows that notes were taken by John M. Aldrich and Alvah George Cross. Both were students at that time, but Aldrich served as Assistant Entomologist during 1888-1891.

Luther Foster, Superintendent of Experiments, issued bulletins on corn and small grains in 1889, 1890 and 1891, but it was not until his successor, E. C. Chilcott, established a crop rotation experiment in 1897 that Agronomy, strictly speaking, can be said to have been organized (W-84). Research, the second of the four major activities of the institution, then became a part of Agronomy.

Agriculturist in Agronomy

E. C. Chilcott initiated the first agronomic experiment in 1897. He summarized the first 5 years results of his crop rotation experiment in 1903 (Bul 79).

It was Chilcott, when Vice-Director of the Experiment Station, who visited the USDA and developed a preliminary agreement for establishing the Highmore Substation (Bul 66). He supervised the establishment of the station in 1899 and may have done the same for the Hunter Farm in 1895.

In 1901 the Experiment Station and USDA entered into a cooperative agreement to conduct small grain variety performance trials. Chilcott took charge of the investigations and the USDA named him collaborator.

The experimentation was conducted at Mellette for 2 years and was moved to Highmore in 1903. The trials included emmer and the first durum wheat ever planted in the United States (Bul 84).

When Chilcott left the Experiment Station June 30, 1905, his assistant, Cole, became the

first Agronomist at SDSU. He continued the work and discovered rust resistance in Iumillo durum and Yaroslav emmer. He may have developed the oats variety, Cole, that was named in his honor in 1909.

Chemist in Agronomy

Soon after the Experiment Station was established, James H. Shepard began working with sugar beets. In 1891 he distributed over 500 packets of seed in 42 counties.

That fall he received reports on the results and samples of beets from 125 growers. He analyzed the beets for sugar content and summarized the reports. He concluded that high yields with good sugar content could be grown without the use of fertilizer on soils in most parts of the state if they were given good cultivation (Bul 27).

Shepard worked to improve the sugar content until his death in 1918. His beet experimentation became famous world-wide and his work in the promotion of the then new pure-food movement brought recognition from the fraternity of American Chemists (W-89).

He was interested in the quality of other crops, also. In the early 1900s he conducted extensive tests on the milling and chemical characteristics of macaroni wheat (Bul 82 & 92).

It was Shepard, when Director of the Experiment Station, who wrote the proposal that resulted in cooperative research efforts between the USDA and the state Experiment Station, and the establishment of the first cooperative station at Highmore (Bul 66).

Botanists in Agronomy

Thomas A. Williams, the first SDSU Botanist, had a great interest in forage crops and planted some plots at Brookings in 1891. In 1895 he reported that smooth brome grass was superior to several other grass species (Bul 45). He may have seeded some of the plots on the Hunter Farm, near Mellette in 1895 and 1896 before he left to join the Division of Agostology in the USDA. His greatest contributions to South Dakota may have come after he left South Dakota, as can be noted in the Chapter, "Profiles of People."

In 1898, Williams' successor, DeAlton Saunders, classified millets produced from 37 seed sources. The next year he laid out the plots on the new Highmore Substation and supervised the plot work, which included an evaluation of many new species for grazing and several crops for winter forage. He left the Experiment Station in October of 1903 (Bul 66 & 70).

W. A. Wheeler carried on the work started by Saunders until 1907. However, in 1904, he and/or Sylvester Balz, Superintendent at Highmore, started a foxtail millet breeding program. A year later they initiated breeding programs for proso millet, sorghum, corn, and alfalfa. They also started a series of crop rotations and initiated a tillage program for small grains (Bul 96).

Dr. E. W. Olive conducted the first weed control research in 1909. He used a herbicide to control mustard in wheat. In Bulletin 112, he thoroughly described the plant physiology involved and the requirements of a herbicide applicator (Bul 112).

Horticulturist in Agronomy

Some of the most significant achievements in Agronomy as well as Horticulture were made by Niels E. Hansen.

In addition to many horticultural crops such as fruits and vegetables, he brought many agronomic crops to the U.S. from his eight overseas trips. Included were Swedish Select oats from Sweden, durum wheat from Central Asia, Hagi lespedeza from Japan, Ladak alfalfa from India and Turkestan alfalfa from Taskent. From Russia and Siberia he brought Kherson and Sixty-day oats, Odessa barley, Kubanka durum, Cossack alfalfa, yellow-flowered alfalfa, crested wheatgrass, Khursch millet, safflower, Red Orenburg, Red Russian, Red Veronezh, Black Veronezh and Tambov proso millets, and hairy sand vetch. He probably brought seed of smooth brome grass, also.



N. E. Hansen



H. Loomis

Agronomists in Agronomy

The seed of Agronomy had been planted. It germinated in 1906 when John S. Cole was named Assistant in Agronomy. The seedling emerged in 1908 when Clifford Willis became Chief in Agronomy, and Howard Loomis was added in 1910. It was vigorous by 1911.

Willis was also Superintendent of Substations from 1908 to 1911. J. V. Bopp was the Chief Assistant in Agronomy in 1909 and 1910, and W. L. Burlison in 1911.

Willis supervised the establishment of the Cottonwood and Eureka substations in 1909 and employed a professional staff member for each substation. P. H. Moore was at Highmore, Samuel Garver at Cottonwood and W. D. Griggs at Eureka. Manley Champlin was appointed as the first USDA collaborator, also in 1909.

Willis revised the plot arrangement at Highmore and incorporated crop rotation and tillage experiments into a crop rotation experiment in 1908. It included 34 3- to 5-year rotations involving spring wheat, oats, barley, corn, brome grass, sweetclover, peas, winter rye, and fallow, as well as several methods of seedbed preparation.

The first crop varieties were developed. Cole oats was released and the first 3 years in the development of Acme durum were completed.

Willis was secretary of the South Dakota Corn Growers and Grain Growers Association from 1908 until he left the state in November of 1911 to become editor of the Northwest Farmstead (JW-7).

INITIAL GROWTH OF AGRONOMY 1911-1943

Dr. A. N. Hume became the first Head of the Agronomy Department in June of 1911. He brought J. G. Hutton with him from Illinois to take charge of soils investigations (W-87). During this period, which has been described as the Hume-Hutton Era, both made many significant contributions to South Dakota agriculture.

Now the Agronomy seedling began to grow. However, it encountered several adversities in the environment. Among the most serious growth inhibitors were World War I, the drought of the mid-1930s, and the depression that lasted more than a decade. During this decade Agronomy suffered from a serious nutrient deficiency of one of the essential elements, money.

Research and Teaching Staff

The names and titles of staff members were taken from Agricultural Experiment Station Bulletins up until 1922. However, names were not included in subsequent bulletins. Some dates may not be exact and the list of staff members during 1922 to 1943 may be incomplete. Full-time instructors, if any, may not be included.

Howard Loomis	1910-1920	Analyst
Dr. Albert Nash Hume	6/1911-1949	Agronomist
Joseph Gladden Hutton	7/1/11-9/23/39	Soils
H. H. Biggar	1911-1912	Soils
Clyde M. Woodworth	1911-1912	Crops
Samuel Garver	1911-1914	Forages
Manley Champlin	1912-1920?	Crops
Irwin S. Oakland	1913-1914	Crops
Matthew Fowlds	1915-1938	Crops-Seeds
Edgar S. McFadden	1915-1920	Cereals (USDA)
Harry Rolling	1916-1917	Asst. Agron.
George Winright	1917-1918	Asst. Agron.
Alfred L. Bushey	1921-1928?	Soils
Dr. Arthur T. Evans	1921-1923	Crops-Pathologist
George Janssen	1922-1922?	Crops
Edward W. Hardies	9/1923-8/1928	Crops
Clifford J. Franzke	4/1/24-10/64	Crops
Dr. Leo F. Puhr	1927-1962	Soils
Dr. K. H. W. Klages	1928-1935	Crops
Dr. Stanley P. Swenson	1936-1941	Small Grain
Edgar Joy	1937-1946	SCS-Wind Erosion
Elmer L. Erickson	1939-1947	Seeds, Weeds, Forages
Ralph Arms	1939-1943	Soils
Dr. John E. Grafius	1941-1953	Small grain
Erhardt R. Hehn	1942-1944	Small grain



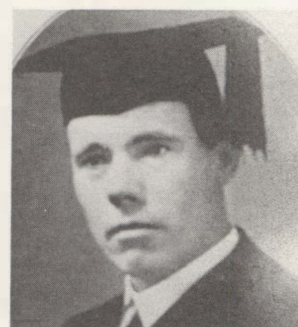
A. N. Hume



J. G. Hutton



I. S. Oakland



M. Fowlds

Howard Loomis, who was listed as Assistant Analyst, was probably succeeded by A. L. Bushey, a soils man. Bushey died in office and was followed by L. F. Puhr who also died in office. Puhr obtained a B.S. degree from SDSC in 1925 and an M.S. in 1927. He received his training from J. G. Hutton who also died while on the Agronomy staff. Only one other staff member suffered this fate.

Sam Garver was at the Cottonwood substation when it opened in 1909 and was appointed USDA collaborator in 1911. In 1914 he took charge of the Redfield Station established by the USDA to conduct alfalfa investigations. It was not determined how long he was at the station. It is known, however, that he appeared on farm programs in 1930, and in 1946 wrote the bulletin that summarized the 21 years (1914-1934) of research done at the station.

Manley Champlin was a USDA employee at the Highmore for 3 years before he was appointed to the Agronomy staff in 1912 to take charge of the cereal investigations at the substations. He may have been succeeded by G. Janssen, who was followed by E. W. Hardies who served as Supervisor of Substations for 5 years. Hardies was followed by plant breeders K. H. W. Klages, S. P. Swenson and J. E. Grafius.

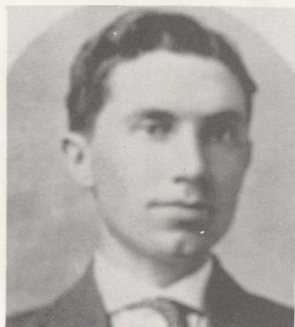
C. M. Woodward had charge of crop testing at Brookings and was followed by I. S. Oakland on Mathew Fowlds. Fowlds became a member of the Entomology Department in 1913, graduated in 1914 and joined the Agronomy Department in 1915. He was a plant breeder, and the first director of the Seed Testing Laboratory where he became the department taxonomist.

Edgar S. McFadden was a plant breeder in the Agronomy Department from 1915 to 1918 when he went to the Highmore Substation as a USDA employee. When that position was discontinued he returned to his farm at Webster until at least 1928. In 1930 he was a USDA employee at the Redfield Station. He may have remained at that location until the station closed in 1934 or 1935.

It is believed that H. H. Biggar was a crop man who was succeeded in turn by H. Rolling and G. W. Winright.

A. T. Evans, former Professor of Botany at Huron College, served as Associate Agronomist-Crops Pathologist for about 2 years. He then joined the Department of Botany and Plant Diseases.

C. J. Franzke was appointed to the staff in April 1924 before he obtained a B.S. degree in June.



M. Champlin



S. Garver



E. Joy



J. E. Grafius

Two of the last men to join the department during this period were Edgar Joy and J. E. Grafius.

Joy was foreman at the Cottonwood Substation for several years during the 1930s before being employed by the Soil Conservation Service as a soils erosion specialist and stationed at SDSC. Grafius had just completed his Ph.D. degree at Iowa State College when he came to South Dakota.

Research Programs

South Dakota was not new to Dr. Hume. He worked on a farm during the summer of 1897 and appeared on the program of the South Dakota Corn Growers and Breeders Association in 1906. Not only did he become Head of the Agronomy Department and Superintendent of Substations, he also inherited the office of Secretary of the South Dakota Corn Growers and Grain Growers Association.

Within a year Hume's broad interests and foresight became apparent. He estimated that the 1910 crop had removed \$25 million worth of nitrogen from the soils of the state and warned that the natural supply could be exhausted within two generations. He believed that the nitrogen used by crops must be replaced by growing legumes and using barnyard manure (Bul 139).

He suggested that South Dakota must have a state wide study of its soil and crop conditions. Solving soil problems was essential to building a state.

"In order for South Dakota to lay a firm and deep foundation upon her soils and crops, she must require the Experiment Station to secure that knowledge, disseminate it and make it reappear on the farms of the State." Hume said, "the Extension feature of the Experiment Station and College ought to go hand in hand with the gathering of facts. Knowledge is not knowledge until it is disseminated. The greatest knowledge is the common knowledge of the common people" (Bul 139).

He further suggested that "the people of South Dakota provide: (1) funds for the Experiment Station to secure and disseminate information about crops and soils and (2) more adequate equipment for teaching Agriculture, not only in the college, but in rural schools and on the farms themselves" (Bul 139).

He suggested that the state's soils be surveyed and mapped, that greenhouse experiments be used to estimate the crops adapted to various soil types and field experiment-demonstrations be conducted on the various soil types to establish facts and demonstrate them to all people. He suggested that many

demonstrations could be located near rural high schools which "will be established before very long" (Bul 139).

Hume, Hutton and Champlin did what funds and other resources would permit in the way of implementing a complete soils and crops program. In 1912 they revised the crop rotation experiments on the West Farm at Brookings and the three substations at Highmore, Cottonwood and Eureka.

At each location a "complete soil investigation" was established on a row crop-small grain-legume rotation. Hutton also established a soil fertility experiment on East Farm in 1912. Experiments at the substations were discontinued in 1936 because of a lack of funds. Those at Brookings were discontinued when work at East and West farms was transferred to the new Agronomy Farm in 1941.

In 1913 the Vivian Substation was established with somewhat less elaborate crop-soil investigations. Champlin coordinated the activities at the station for 7 or 8 years.

Hume, Hutton and other staff members met regularly with the Corn Growers and Grain Growers Association. At the 1913 meeting the Association voted to ask the State Legislature for \$15,000 per annum and demand that the Experiment Station make more adequate study of soils, tillage and cultivation methods, and varieties of corn and other grains (JW-9).

The group also voted to ask the Legislature to amend state laws so that county commissions could use county funds to cover the expense of a county or district farm demonstrator who "shall" work closely with the Experiment Station (JW-10).

More than one county had a farm demonstrator and Hume, because of his interest in Extension, became the first County Agent Leader in 1913 (Ext-4).

He strongly believed that the Extension work should be done by Experiment Station personnel and wrote many letters to justify his position. However, the Extension Service became a separate agency in 1914 and a new County Agent Leader was named in 1916.

Ralph E. Johnston became the first Extension Agronomist in 1920 and Ralph E. Hansen the first Extension Soils Specialist in 1939. Though neither was assigned to the Agronomy Department, they added the third of the three areas of activity--Teaching, Research and Extension--in Agronomy.

The CG & GGA voted in 1913, 1916 and 1918 to ask the State Legislature for funds for a

soil survey program. Finally in 1919, the Legislature appropriated \$10,000. Hume was the supervisor of Soil Survey, but Hutton directed the work that began June 11, 1919. The soil survey staff included one USDA soil surveyor and two students (JW-9-12).

Weed control became an agronomic function in 1916 when Hume wrote a bulletin about controlling quackgrass. A. L. Bushey applied several chemicals for the control of field bindweed in 1926 and C. J. Franzke tested several methods for controlling the weed from 1931 to 1935 at Brookings and the three substations.

The State Seed Laboratory was established in 1921 with Mathew Fowlds as Seed Analyst. After he addressed the Corn and Grain Growers Association in 1921, the group voted in favor of an increased appropriation of at least \$2,000 for seed testing and "for the distinct purpose of developing improved disease-resistant varieties" (JW-16). Seed testing was a Statewide Service and the fourth of the four major activities--Teaching, Research, Extension and Statewide Services--of SDSC to be provided in Agronomy.

New Varieties

Plant breeding techniques were modernized and conducted on a scientific basis during this period.

While at Highmore, Champlin made head selections from Kubanka durum and grew them in head rows. J. D. Morrison continued the work and in 1915 decided to increase Selection 7 and name it Acme.

Selections were made from White Smyrna barley at Highmore in 1915, probably by Morrison. By 1922 the selection was included in variety performance tests as Ace.

Mathew Fowlds developed Fowlds hulless oats at Brookings in a similar manner and during the same period. It was first tested as a variety in 1923.

In 1916 Edgar S. McFadden initiated the modern method of plant breeding in South Dakota. He cross pollinated Yaroslav emmer with Marquis HRS wheat. In 1918 he took seed to Highmore when he joined the substation staff. During 1920 he selected the lines that he developed into the varieties Hope and H44. While at Highmore he initiated the barley breeding program and made several crosses involving Coast, Lion, Manchuria, Odessa and Club Mariout. One double-cross became the variety Dryland.

Fowlds developed Nakota hulless oats, and S. P. Swenson made the crosses that became

Plains and Feebar barley and Miomark oats during the 1930s.

During the early years of the Experiment Station, seed corn was obtained by selecting the best ears from the field. SD 86 and Alta were developed. Later, All Dakota was developed at Brookings. In the 1930s C. J. Franzke started a hybrid corn breeding program. He developed seven inbreds by selfing open-pollinated varieties and used these inbreds to develop four double-cross hybrids.

Also during the 1930s Franzke developed the first of the two low-prussic-acid forage sorghum varieties ever developed.

Though Hutton and Champlin were gone, L. F. Puhr established new crop rotation experiments in 1941. They included soil management investigations on the new Agronomy Farm at Brookings and at the Highmore and Eureka substations.

Seed Certification and Distribution

The problem concerning the certification, increase and distribution of seeds of new varieties was discussed at the annual meeting of the South Dakota Crop Improvement Association in 1938. In 1940, at a special meeting it was decided that foundation seed be released to County Crop Improvement Associations (JW-45).

Other problems arose in 1941 and 1942. Crop Improvement members did not have facilities to raise and process single-cross seed of corn and FFA chapters were not equipped to produce, process and market double-cross seed.

A. O. Syverud was employed on July 1, 1943, to handle the increase of new varieties. Also in 1943 the SDCIA was making plans for a Foundation Seed Stocks Corporation (JW-48).

The official work week was 8 a.m. to 5 p.m., 6 days a week. However, most staff members and their student assistants worked from 7 a.m. to 6 p.m. during the growing season. Students, who worked part-time during the school year, frequently worked outside of regular office hours.

Agronomy as Remembered by Hardies

Edward W. Hardies was Supervisor of Experiment Farms from September of 1923 until August of 1928. In 1973 he wrote a short history.

E. W. Hardies

The experimental work was conducted on five stations. The main station was at Brookings where soil investigations assumed a major role. Extensive studies were made with rates,

analysis and amounts of fertilizer on crop yields. Rotation systems also played a major part of soil investigations at Brookings.

Substations were located at Highmore, Eureka, Cottonwood and Vivian. An effort was made to have a station in a locality where the soil, climatic and environmental conditions were different from any of the other stations. The environmental factors and the general ecology of an area determined the kind of agriculture and the species of plants that could be profitably grown.

The Highmore Substation was one of the first agricultural experiment stations in the Northern Great Plains. Much of the early work done there was in cooperation with the United States Department of Agriculture. The Highmore station is noted as the first place in the U.S. where durum wheat, smooth brome grass, yellow-blossomed alfalfa, Siberian pea and Russian olive were tried and proved to be valuable introductions for the nation's agriculture. Russian olive and Siberian pea are shrub-like trees valuable for wind breaks and shelter belts in the prairie states. Smooth brome grass proved to be adapted to South Dakota and many other states. It was recognized as an important grass for the production of hay, grass silage, pasturage and for the control of soil erosion. The yellow-flowered alfalfa, *Medicago falcata*, was a low-growing rhizomatous species that was extremely winterhardy and droughtresistant. It was tried as a possible pasture plant. It proved to be of great importance in plant breeding. Many important varieties of alfalfa were developed by using *Medicago falcata* in crosses.

Eureka was known as the largest wheat shipping center of the world. Wheat was grown exclusively and hauled for distances of 50 miles or more to the shipping point. The shipping of wheat began at harvest time and lasted throughout the winter. Because of the importance of wheat in a large area, the main project on the experiment station was devoted to testing wheat. Hundreds of varieties were tested for their adaptability, resistance to black stem rust and yielding ability.

The Cottonwood Substation was established in an area where grazing and livestock was important. Consequently, forage plants were tested there. Species of brome grass, wheatgrass and alfalfa were extensively tested. As the prairie was broken, wheat and flax were grown and included in the experimental projects. The area of the station was too small for grazing tests and livestock carrying capacity determination.

The Vivian Substation was the last to be established. The climatic conditions existing there indicated that sorghums would be a good crop for that area. The outbreak of World War I and the depression that followed resulted in curtailment of funds. Consequently, the work at Vivian was not expanded.

During the first quarter of this century, research work in Agronomy was largely devoted to study the adaptability of cereal and forage species to the different climatic conditions and soil types found in South Dakota. It was a study in crop ecology involving many species and varieties. Introductions from vast areas of Russia and China were grown. Conditions in those countries were similar to those in South Dakota. Introduction and selection were the two methods of plant improvement used.

Improvement by hybridization was the next step. Work in hybridization received its momentum with the rediscovery of Mendel's studies with the crossing of numerous species of plants. It is the basis of all genetic work. It was 50 years after Mendel published his observations that three European scientists, working independently and in different countries, discovered and recognized the great importance of his work. The agronomists of the world now had the genetic foundation on which to proceed.

The beginning of World War I in 1914 and the entry of the United States in the war in 1917 created the incentive to produce more food. "Food will win the war" was the American slogan.

The epiphytotic of black stem rust during those years caused the loss of an estimated 4 million bushels of wheat in South Dakota. The United States began a gigantic campaign to eradicate the common barberry, the alternate host of the pathogen causing black stem rust. Agronomy took an active part in establishing cooperative regional nurseries for the study of the resistance of different wheat varieties to the disease. Hundreds of varieties and crosses were planted at Highmore and Brookings. Those that showed the greater resistance to stem rust were studied for yield, milling qualities and acceptability by the wheat industry.

The improving of corn by inbreeding, a method of purifying and then crossing was suggested by Dr. Beal, a botanist of Michigan State University in 1895. About 20 years later Agronomists recognized the possibility and began intensive work with corn improvement.

Dr. A. N. Hume designated Professor Franzke to proceed with the corn breeding

program in South Dakota. He was the first one in the state to self pollinate and cross inbred lines of corn. Hybrid corn replaced open-pollinated corn and greatly expanded the corn producing area.

As more land was placed under cultivation, an increase of weeds followed. The distribution of crop seeds, crop shipment, introduction from foreign countries and other states contributed to weeds becoming a greater pest. Creeping jenny or field bindweed became widespread in South Dakota and other states. Some farms were abandoned because of the weed. A system of fallowing followed with a heavy seeding of winter rye carried on for 2 successive years was conducted. This two-pronged attack of fallowing and using a smothering crop was successful in eradicating creeping jenny. In 1926, Professor Bushey tried a number of chemicals for weed control. Using chemicals as a herbicide was discontinued because of Bushey's untimely death.

Sorghums were introduced in South Dakota in 1896. These species withstood more drought than corn and produced feed in areas where corn was a failure. The sweet sorghums and sudans were grown for pasture and forage. Unfavorable growing conditions brought about a high concentration of prussic acid. Heavy livestock losses were often reported when cattle were pastured on sudangrass. Franzke developed a low-prussic-acid variety which could be safely used for pasturage.

Harvesting early varieties of tall-growing sorghums was a problem and resulted in limited production of this crop. The Agronomy Department launched a program of sorghum improvement. The great success in improving corn by inbreeding and then crossing provided the early attempts to improve sorghum. The corn plant was monoecious and removing the male flowers was an easy task. The sorghum plant had perfect flowers containing anthers and stigma. It could be self-pollinated as well as cross-pollinated. The technique of selfing and controlled crossing was developed.

GRAND PERIOD OF GROWTH IN AGRONOMY 1943-1958

Just as the preceding third of a century can be described as the Hume-Hutton Era, this 15-year period can be designated as the Worzella-Norgaard or Worzella-Norgaard-Sanderson Era.

Dr. Wallace W. Worzella was Head of the Department of Agronomy and U. J. Norgaard was the Extension Agronomist for the entire period. Worzella was a dynamic individual with many progressive ideas. Norgaard had many years of experience and understood South

Dakota people and agriculture. He knew what needed to be done and believed that it could be done if the people understood the needs. In 1944 E. G. Sanderson became the energetic President of the South Dakota Crop Improvement Association. For more than a decade, he used his influence in the Legislature.



W. W. Worzella and A. N. Hume

Initial growth of Agronomy was complete. It was time for the grand period of growth. Many badly needed facilities were acquired and the size of the staff in the Agronomy Department increased from six to 33. Numerous members of the staff became distinguished Agronomists.

One of them was Dr. John E. Grafius. During his years at SDSC, he became an outstanding scientist. Because of the work done by Grafius and C. J. Franzke the Agronomy Department became recognized as a source of new crop varieties and hybrids. Unfortunately, Grafius left for greener pastures in 1953. At Michigan State University he became a distinguished plant breeder and won high acclaim from far and wide.

Although he lived in Michigan, he always had a warm spot in his heart for South Dakota where he started his professional career, met his wife and became close friends with many co-workers. In April of 1979, he responded to a request to write something for this history. Many co-workers and former co-workers mourn his untimely passing in January of 1980 at the age of 63.

Agronomy, South Dakota Style, in the Forties
J. E. Grafius

The agriculture of South Dakota in the late 30s and early 40s was still emerging from the horse agriculture which had settled the Dakotas.

Experimental plots at the various substations were still objects of derision by many of the farm folk. The use of commercial fertilizer was practically unknown and, except for phosphorus, was not recommended.

Nobody worried about soil organic matter and in the early spring on "good burning days", the sky was all aglow as farmers readied their fields for planting. Field preparation often consisted of burning and then a once over rig consisting of a disk, followed by a drill, followed by a drag.

The agricultural world of South Dakota was changing, however. As the legendary phoenix, South Dakota of the 40s arose from the ashes of the terrible drouths, dust storms, grasshoppers, stem rust epidemics and economic depression of the 30s.

The idea of progress through education and research had been implanted in various farm communities. These communities were to furnish the support on which a vigorous and productive Agronomy Department was to be built, but in 1942 such a development was not even a dream. There were only a few people in the Department and there was very little in research equipment or funds. While the staff on hand did an admirable job, the job was just too big for the resources available.

The Department as I remember it was represented by: A. N. Hume, Chairman; Clifford J. Franzke, corn, sorghum and grass breeder; Elmer Erickson, seed technologist and agronomist; Leo Puhr, soil fertility expert; U. J. Norgaard, Extension specialist; Edgar Joy, soil conservation specialist; Elmer Sanderson, farm foreman and part-time student; and Erhardt R. Hehn and Ralph Arms, graduate students. Still fresh in the memories of the staff were Hutton, (deceased) former professor of soils and Departmental poet laureate, Matthew Fowlds, oats breeder, and S. P. Swenson, a small grain breeder and teacher par excellent who had moved to Washington State University.

Just listing names does not make a history. The lives of people in the Department enriched the community and the entire state. Some of them made extraordinary contributions to agriculture.

Dr. Albert Nash Hume was a gentleman and scholar of the old school. Coming out of Illinois, he assimilated the philosophies of scholars such as Davenport and Hopkins. He completed his Ph.D. at Goethegen, Germany. This was about the time of the rediscovery of Mendel's laws by Correns and Tschermak and Dr. Hume had the thrill of hearing Correns lecture on Mendelism.

Dr. Hume's "old world" type of courtesy and manner of speaking frequently came as a shock to students and younger members of the staff. Most of us came to realize, however, that if we listened carefully there was a message. Sometimes we learned this the hard way.

Dr. Hume will be remembered as a teacher and as a friend. Among his most informative research efforts I would list his long time rotation experiments and his prairie hay management studies.

Lest you believe there was only the pedantic professional side to Dr. Hume (no one ever called him Albert) let me hasten to add that we had some great times together. The fall pheasant hunts were times to remember. At the time I first knew him, Dr. Hume was about 65 but he could still tramp all day. His ritual after a successful shot was to break his double barrel and blow through it. Why, I don't know. But I can still see him silhouetted against the prairie sky, blowing smoke out of the old double.

Dr. Hume hired Clifford Franzke in 1924 shortly after the close of World War I. Cliff had lost an arm during the war but he did more with one arm than most could with two, figuratively and literally.

Cliff developed the inbred lines of corn which formed the first Sokota hybrids. He developed several outstanding lines of grain sorghum, the first low-prussic-acid forage sorghum and a pythium root-rot-resistant strain of crested wheatgrass as well as improved strains of fescue and wheatgrass. All in all, his is quite a record of achievement.

Leo Puhr had a brilliant mind, a charming personality and added a bit of class to the younger (at that time) set. He was an excellent teacher and a first rate expert in soil fertility.

At the time I first knew Leo, the soils of South Dakota were considered young. Commercial fertilizers were, it was thought, not needed. Leo started his work during this period and was part of the group which brought about great changes in soil management programs in the State.

The funniest story about Leo is entitled "the night Leo stuck up the gas station in Cicero, Ill.". It happened this way.

Leo was always very elegant and in the winter wore a rather formal black topcoat and black homburg. Hoods of the time were often very elegant and often wore formal black topcoats and black homburgs. Put the ideas together on a dark cold night at a lonely gas station in northern Illinois.

Here was Leo with several of his colleagues standing silently around the car, hands deep in their overcoat pockets. How would you feel if you were the gas attendant? After nervously spilling gas all over, and fumbling with the change, the attendant whispered in an aside to Leo, "All your guys got gats?"

Edgar Joy added that special fillip needed to make a Department go. Not only was he a fine scientist but he was fun. Edgar was highly competitive and it didn't matter what the activity, hunting, fishing, or you name it, he was game to try. Usually he won.

Edgar built one of the first wind machines to study wind erosion. His study on the effect of rotation and tillage on wind erosion was far ahead of its time. When the Soil Conservation Service in its infinite wisdom decided to close out the project, it destroyed a good thing.

Erhardt Hehn was a graduate student in the early forties. After getting his M.S. degree he was employed as an instructor and worked as a small grain breeder. Erhardt was drafted and after the war completed his graduate work at Iowa State University and eventually became Department Head at Montana State University.

Elmer Sanderson, farm foreman and part-time student, had the handicap of an illustrious father, E. G. Sanderson, who along with a small number of farmers helped bring about support for agricultural research. Elmer overcame the handicap and became an outstanding Extension specialist.

Another Elmer, Elmer Erickson, brought his special talents to the Department in 1939. Elmer was the seed analyst and agronomist (forage crops and weeds) but I've often thought that his greatest interest lay in inventing gadgets to do things better. Elmer had a real genius in this respect and eventually resigned to devote full time to the creation and manufacture of scientific equipment. Many of us have benefitted from his "hobby."

And then there was U. J. Every Agronomy Department should have a U. J. Norgaard. U.J. was tall, thin and slow of action. But when he spoke his deep voice conveyed words of wisdom.

U. J.'s responsibility was Extension but in order to do his job he needed something to extend and he made sure he got it by directing the research. Oh, it was done subtly. None of us really knew until much later what was happening. Whenever a new staff member arrived, U. J. would spend hours indoctrinating him with the facts, fables and problems of South Dakota.

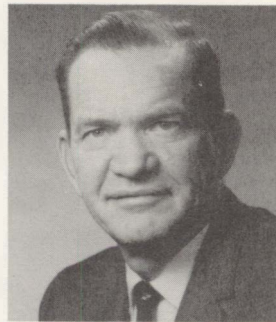
The phrase "Farming around July" came from Norgaard. It was the result of his experiences in Sully County during the thirties.

I can see him now, standing in the middle of a devastated grain field with the grasshoppers chewing on his collar saying to himself, "This won't work. This is wrong. If we just had earlier small grain varieties we could beat the July drought. And sorghums could become dormant in July and then recover in August if we got some rain. Let's farm around July".

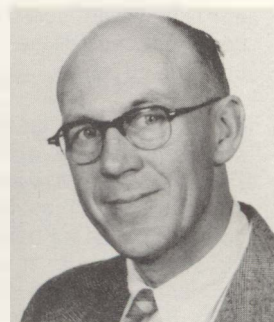
This was the story that U. J. preached to the newcomers, and basically he was right. U. J. was an outstanding teacher acting in the role of Extension Agronomist. He knew that programs imposed on the people had only a temporary effect. For a program to last, the people had to be taught to understand. U. J. had a major role in building a strong Crop Improvement Association which in turn spearheaded a renaissance of agricultural teaching, extension and research in South Dakota.

About this time--1943--another exciting person came on the scene to team up with U.J. A man by the name of W. W. (Wally) Worzella came from Purdue University to head up the miniscule assembly of people which we called an Agronomy Department. The two of them made an unbeatable pair. Together, they had the dream of a greatly expanded staff furnished with adequate facilities, revolutionizing the agriculture of the State. And to a large extent, working through the people, they made it happen.

I'll end this here, since I believe that the saga of Wally Worzella and South Dakota will be told in its entirety elsewhere. Suffice it to say he was one of the most dynamic department heads that I have known. His leadership qualities were unsurpassed. He had his staff believing that they were the best in the business. And because of this belief, who knows, perhaps we were.



J. E. Grafius



J. G. Ross

Agronomy, A Synonym for Enthusiasm
J. G. Ross

What I remember most about the Agronomy Department when I first came in 1947 was the terrific morale that was due wholly to Dr. Wally Worzella.

There wasn't anything that couldn't be done. The opportunities for improvement in the state were circumscribed only by our imagination. The newcomers were young, just out of graduate school and filled with new ideas and enthusiasm.

We weren't concerned with financial security but we did have a real concern to improve conditions in South Dakota. We had confidence that the political situation in the state would change so the opportunities for increasing better agronomic practices and varieties would be exploited by providing the tools for getting the job done.

The combination of vigor, ideas and enthusiasm residing in Wally Worzella coupled with the philosophy and knowledge of the state of U. J. Norgaard gained through a lifetime spent in the Extension Service, provided a master plan for accomplishing the necessary changes to bring about increased stability through consistently increased yields of crops in South Dakota.

The other member of this team was E. G. Sanderson, an idealistic farmer who took a great interest in public affairs that had to do with the welfare of agriculture and Agronomy in particular. He was the means by which the ideas concerning crop improvement were carried to the legislature and the money made available for a new Agronomy Seedhouse and Greenhouses so new varieties, high yielding and adequately adapted to South Dakota conditions, might be produced and so that agronomic soil fertility and management practices that would give the full potential of these varieties could be developed.

The new Seedhouse had recently been completed when I arrived on the scene. The old Seedhouse was a wooden frame structure heated with a pot-bellied stove so large-scale research work would have been impossible especially with the increase in staff that was taking place. The only Greenhouse was a small lean-to on the south side of the Administration Building.

Our offices were makeshift affairs in the "bowling alley" that provided a hallway on one side of a large room and gave access to offices formed by wooden partitions. This didn't bother us because we weren't concerned with

physical surroundings, only with the tools to get the job done.

When I arrived with Wayne Adams in the spring of 1947 to interview for the grass breeding position, newly created positions were being filled by individuals who, as was shown in the future, elected to stay for a good part or all of their professional life. Boyd Shank, corn breeding; Larry Fine, soil fertility; Fred Westin, soil survey; Lyle Derscheid, weeds; Vic Dirks, small grain breeding; Wayne Adams, legume breeding; Paul Carson, soil testing; Ray Kinch, seed testing; Ralph Cline, SCS wind erosion, and in addition to those who were already here, made up a cadre of enthusiastic research workers whose group enthusiasm was contagious and affected us all.

Cliff Franzke, who had been with the department since 1924, had an enviable reputation as a breeder in such diverse crops as corn, sorghum and grasses. He was an excellent selectionist and could pick out types that would be adapted to conditions in the state with great acuity. He elected to retain sorghum as the crop that he would continue working with as funds became available for hiring other plant breeders.

I remember with great pleasure the fall harvesting trip that I took with him shortly after starting my tenure in the department. He had a story about each part of the state through which we passed and drove the state car with his one arm better than 90% of people can with two.

The beauty and diversity of the state made a never-to-be-forgotten impression on me and I was sold on the opportunities for crop improvement that were present both in the more humid croplands of the east and the beautiful grasslands of the west.

I cannot pass over these years without mentioning the delightful association with Wayne Adams. We came from the University of Wisconsin in 1947 and formed a team in our efforts to breed improved forage crops for our area. It was exciting to discover the remnants of the alfalfas that N. E. Hansen had brought from Russia and to observe how they had undergone natural selection under the South Dakota environment. Wayne had an extremely agile and keen mind which made working together a real pleasure.

In the winter of 1947-48, plans for an experiment to test the adaptability and yield of adapted grass species and varieties were made. An experiment was seeded at Brookings, Eureka, Highmore and Cottonwood the next spring. As Dr. Worzella remarked, we were

very lucky because excellent stands such as were obtained, not always occurred.

Adams and I had no fancy plot seeding equipment but took the grass and alfalfa seed mixed with killed barley to the various experiment stations in bags, calculated pounds per acre according to the drill at the station, and seeded the 4-replicate experiments.

From these experiments it was found that Ree Intermediate wheatgrass yielded more than other grasses, alfalfa in mixture with grass yielded more and that a lower yielding grass in mixture with a high yielding grass lowered the yield. These experiments lasted for about 20 years or more and would have continued to give good data on longevity if they could have been preserved.

Research and Teaching Staff

The names and dates for staff members with rank of Instructor or above, for this period were taken from departmental budget records for the years 1953-1957.

Dr. W. W. Worzella	10/1/43-1/10/58	Dept. Head
Dr. A. N. Hume	7/1911-7/1948	Dept. Head, Corn
Clifford J. Franzke	4/1/24-10/64	Corn and Sorghum breeding
Dr. Leo F. Puhr	7/1/27-10/1962	Soils
Edgar Joy	193?-1945	SCS Wind erosion
Elmer E. Erickson	1939-1947	Forage, Weeds
Dr. John E. Grafius	1941-1953	Small grain breeding
G. Dwight Johnson	3/1942-1956	Seed Certification
Erhardt R. Hehn	7/1/42-6/10/43	Small grain breeding
A. O. Syverud	7/1/43-7/1956	Foundation Seed Stocks
Glen Avery	1945-?	SCS Soil Scientist
Karl F. Manke	1944-1946	Corn breeding
Norman G. Patterson	1944-2/1947	Seed Testing Lab
Ralph A. Cline	2/1946-10/31/49	SCS Wind erosion
Dr. L. M. Stahler	1946-1950	Weeds (USDA)
Dr. Lyle A. Derscheid*	3/16/46-6/30/64	Weeds
Dr. Lawrence O. Fine	7/1/1946-	Soil fert., Irrig.
Dr. D. Boyd Shank	10/1946-6/30/80	Corn breeding
Raymond C. Kinch	2/1947-6/30/76	Seed Testing Lab
Victor A. Dirks	1/1947-1961	Small grain breeding
Dr. M. Wayne Adams	5/1947-11/1958	Alfalfa breeding
Edward J. Williamson	7/1/47-12/30/47	Soil Test Lab
	1/1/48-6/1954	Soil Test. (USDI)
Jason S. Webster	7/1947-1956	Teaching
John H. Miller	9/1/47-12/31/47	Weeds & Teaching
Dr. Frederick C. Westin*	7/1/47-5/11/81	Soil survey
Dr. James G. Ross	9/1947-5/31/81	Grass breeding, Cytology
Paul L. Carson	1/1/48-	Soil test. & fertility
Ross Greenawalt		SCS Soil Scientist
Gerhardt W. Erion	5/20/48-	FSSD & Performance testing
Dr. Donald E. Kratochvil*	1/1948-3/10/51	Asst weeds and Teaching
	8/1952-1960	Asst Corn breed. & Teaching
Raymond Walz	1949-1951	Asst Seed Testing Lab
Glen E. Nachtigal	1951-1952	Asst corn & teaching
William C. Moldenhauer	7/1949-3/1954	Asst Soil survey
A. J. Klingelhoets	1948-?	Asst Soil survey
Gerhardt B. Lee	1948-?	Asst Soil survey
Dr. Burton L. Brage	6/1950-1959	Soil fertility
Dr. George J. Buntley*	7/1950-6/1968	Asst Soil survey
R. E. Campbell	7/1950-1954	Asst Irrigation
Dr. Fred E. Shubeck	8/1/1951-	Soil fert. & Manager
Mark W. Johnson	8/1951-1955	Asst Seed Testing Lab

Frank Wiersma	2/1953-1955	Asst irrigation
Dr. Dale D. Harpstead*	8/1/1953-1961	Oats & Flax breeding
Edward J. Williamson	12/1954-10/1955	Mobile Farms
Howard M. Vance	1955-1959	Asst irrigation (USDA)
Rodney C. Dodge	1955-1959	Asst Soil Testing Lab
Dr. Everett M. White	6/1954-	Soil survey
Dr. Jack R. Runkles	12/15/55-1963	Soil physics
Quentin S. Kingsley	1955-	Mobile Farms
Dr. Raymond A. Moore*	1956-1973	Pastures & Head
Lawrence Wilding	1/6/56-1/6/59	Asst Soil survey
Dr. Charles Swanson	1956-1960	Alfalfa physiology (USDA)
Dr. Mary E. Sanders	1956-1961	Asst Sorghum breeding
Dr. Phillip B. Price	12/21/57-	Barley breeding (USDA)
Harry A. Geise	4/1/1958-	Mobile Farm
J. Duane Colburn	1957-1978	Seed Certification

* Obtained Ph.D. degree while a member of staff.

New Programs

When Wallace W. Worzella became the second Head of the Department of Agronomy on October 1, 1943, many worthwhile projects were underway. However, additional resources and time were needed to give maximum benefits to the taxpayer.

At first he directed his attention to completing the organization of the New Agronomy Farm and the establishment of the Foundation Seed Stocks Division.

At a SDCIA board meeting on February 2, 1944, the Association activated the Foundation Seed Stocks Division of the South Dakota State College Foundation (JW-49).

Its function was to increase varieties developed by the South Dakota Experiment Station and maintain pure seed reserves of standard varieties. The board of directors of the corporation included five farmers and six representatives from SDSC--President, Dean of Agriculture, the Directors of Experiment Station and Extension Service, Head of Agronomy and Extension Agronomist (JW-49).

Its first task was to increase the 50 bushels of Vikota oats that were allocated to South Dakota by the Regional Oat Committee in 1944. They were seeded on 17 acres of the Agronomy farm and yielded 142.5 bushels per acre. Farmers, who saw the crop growing, were impressed with the future potential of Agronomic research. They were more impressed when they learned that they could get the oats for \$1.50 a bushel instead of the \$10 to \$15 asked by seedsmen. This was a "shot in the arm" to initiate a sound Agronomic Program (Worzella).

Worzella, president of the FSSD, announced at the end of the 1944 growing season that some 2,000 bushels of Vikota oats and 400 bushels of Kota flax (from North Dakota) were in the warehouse. Sufficient handpollinated seed of inbred lines of corn had been produced to grow all of the single-cross stocks needed in 1945. Single-cross seed produced in 1944 made very satisfactory yields. Soybeans (Ottawa and Mandarin) were not yet harvested, but the crop was expected to yield well (JW-49).

About the same time, E. G. Sanderson, Harold Woldt, Silas Minor and others who had attempted to raise single-cross seed of corn, formed Sokota Hybrid Producers Cooperative. Members bought single-cross seed, which had caused them so many production and processing problems, from the FSSD. They raised double-cross seed and delivered it to the cooperative that processed and marketed it. Corn hybrids developed in South Dakota and adapted to South Dakota conditions were finally available to commercial growers. Sanderson was president of Sokota for over a decade.

Though seed was available to anyone, no one took advantage of the opportunity except Sokota. This producers cooperative of corn farmers, expanded considerably over the years. In 1978 it processed over 350,000 bushels, sold over 140,000 bushels of processed seed, and grossed over \$4 million.

Crop rotation and soil fertility experiments were established on the new Agronomy Farm by Leo F. Puhr in 1941. Worzella determined the plot arrangement on the remainder of the Farm. A graded and gravelled horseshoe

shaped road was installed and about one third of the farm was included in a 3-year crop rotation of row crop-small grain-green manure crop.

Performance tests and breeding nurseries of various crops were used as the row crops and small grains in the rotation. The eastern portion of the farm was frequently used as a seed increase field for new varieties.

Dr. Karl Manke was hired in 1944 and relieved C. J. Franzke of his corn breeding responsibilities. Franzke could then spend more time on sorghum. They shared Franzke's old office.

Norman B. Patterson was hired as an assistant to E. L. Erickson who was in charge of the Seed Laboratory. Erickson then had more time to devote to forage crops and weed control.

The Seed Laboratory was moved from the Administration Building to the second floor of the headhouse for the Horticulture Greenhouse. The old Seed Laboratory was remodeled to provide office space.

Interest in weed control increased. In 1934 the board of the SDCIA passed a resolution in favor of starting a Creeping Jenny Experimental and Demonstration Farm in Southeastern South Dakota. The resolution suggested that SDCIA funds, if possible, be used to start such a project and was forwarded to SDSC (JW-39).

At the SDCIA annual meeting on August 31, 1944, President E. G. Sanderson pointed to a need for a concerted effort to control and eradicate noxious weeds. The board decided to sponsor a new weed law at the next legislative session (JW-50).

Worzella, Norgaard, E. L. Erickson and Richard Burn of the Seedsmen's Association wrote a bill that would provide for a State Weed Board (JW-51). Sanderson guided it through the legislative process and it was passed by the Legislature in 1945.

The law established a State Weed Board and specified that organization of the program was to be handled by the Weed Board, research by the Agronomy Department, education by the Extension Service and law enforcement by the State Department of Agriculture.

The ten-member board included individuals that were given responsibilities by the law (Secretary of Agriculture, Head of Agronomy Department and Director of Extension), state officials that controlled land (Commissioner of School and Public Lands, a State Highway

Commissioner and a member of the Game, Fish and Parks Commission), presidents of farm organizations (South Dakota Crop Improvement Association, South Dakota Horticultural Society, and Association of Soil Conservation District Supervisors), and the president of the State County Commissioners Association (County Commissioners controlled county purse strings). E. G. Sanderson was elected president and held that position for 10 to 12 years.

Though the Weed Law did not include an appropriation for weed control, Worzella arranged with the USDA to have L. M. Stahler transferred to SDSU. Stahler was closing the USDA Field Bindweed Research Farm at Lamberton, Minnesota, and was the USDA weed research coordinator for Minnesota and the Dakotas. On March 16, 1946, Worzella employed Lyle A. Derscheid on a half-time basis to establish and operate a Field Bindweed (Creeping Jenny) Research and Demonstration Farm at Scotland in Southeastern South Dakota. When funds appropriated by the 1947 Legislature became available, he was employed on a full-time basis.



L. M. Stahler



Lyle A. Derscheid

Worzella had plans drawn for a four-building Agronomy complex. Plans included an office building, seedhouse, greenhouse and a service building to be built north of 11th Street and east of Medary Avenue.

The SDCIA board was impressed with Worzella's enthusiasm and with the potential for research with improved research facilities. It sponsored a bill in the 1945 Legislature for a special appropriation. The bill passed and provided \$100,000 for an Agronomy Seedhouse. Construction was completed early in 1947 and it was dedicated to the development of adapted crops and better soil practices during Agronomy Field Day on July 10, 1947 (JW-54).

Staff Expansion

In February of 1946 Ralph A. Cline, SCS Soil Scientist, replaced Edgar Joy. L. O.

Fine joined the soils staff on July 1 to do soil fertility research and teach, and D. Boyd Shank replaced Manke in October of 1946.



L. O. Fine



D. B. Shank

In April of 1946, E. R. Hehn returned from World War II to assume a full-time position as small grain breeder. He was not satisfied with the salary he was offered and went to Iowa State College where he obtained a Ph.D. One year later the position was filled by Victor A. Dirks. He and J. E. Grafius shared Grafius' old office.



R. A. Cline



V. A. Dirks

Though advanced degrees had been conferred on an irregular basis for about 20 years, the graduate program became a permanent function of the Agronomy Department in 1946.

In February of 1946 John H. Miller and Walter N. Nelson were employed as graduate research assistants to work with alfalfa and small grains. A month later Lyle A. Derscheid assumed a similar position in weed control. Ralph Arms returned from the service to complete work on an M.S. in soils. A year later Dwight G. Lambert was awarded an assistantship in seed technology and Donald E. Thompson had a similar position in small grain breeding. The graduate program was underway.

1947 was a banner year for growth at SDSC and the Agronomy Department, partially due to the efforts of the SDCIA.

The board realized that, in addition to new buildings, a larger Agronomy staff was necessary to accelerate crop improvement work in the state and met with the college administration in this regard (JW-51).

Since such improvements depended on legislative appropriations, the board decided to keep a lobbyist in Pierre during the legislative session to acquaint legislators with the needs of crop improvement personnel and facilities. Also, the weed program needed an appropriation to activate the law passed in 1945 (JW-54).

Legislative coffers were opened and special appropriations for SDSC totalled almost \$1 million. These included \$140,000 for an Agronomy Greenhouse and \$400,000 for Agricultural Hall (K-102).

The total appropriation for the College reached the 1923-24 level. Appropriations that took 10 years to drop to the 1933 low required 14 years to rebuild (K).

During 1947 Patterson resigned from the Seed Laboratory and E. L. Erickson resigned to enter private business in Brookings. Raymond C. Kinch became seed analyst on February 1. M. Wayne Adams became the new legume breeder in May and James G. Ross started as a grass breeder in September.

On July 1, Lyle A. Derscheid became the first full-time weed control researcher, Jason S. Webster became the first full-time instructor and Edward J. Williamson established the Soil Testing Laboratory.



R. C. Kinch



J. S. Webster

John H. Miller was hired September 1, 1947, to work half-time with Webster as a teaching assistant and half time with Derscheid on the weed research project. Gerhard W. (Bill) Erion started as Assistant Manager of the Foundation Seed Stocks Division. Miller left in December of 1947 and was replaced by Donald E. Kratochvil on January 1, 1948.



F. J. Williamson

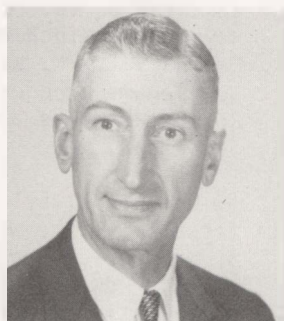


D. E. Kratochvil

Williamson resigned December 1 to set up a Soil Testing Laboratory for the Bureau of Reclamation which was initiating a program to analyze the soils on the proposed Oahe Irrigation District in Spink and Brown Counties. Paul L. Carson took charge of the state laboratory on January 1, 1948. Together they developed a laboratory in the old Agronomy storeroom of the Administration Building.



P. L. Carson



G. W. Erion

The soil survey program that was suspended during the depression was rejuvenated when Frederick C. Westin was hired July 1, 1947, to head up the program. The following year Gerhardt B. Lee and A. J. Klingelhoets were added to the soil survey staff. They shared office space with Ralph Cline. James Anderson, William Moldenhauer and George J. Buntley were students on the early survey crews. Moldenhauer became a staff member in 1949 and Buntley was hired one year later.

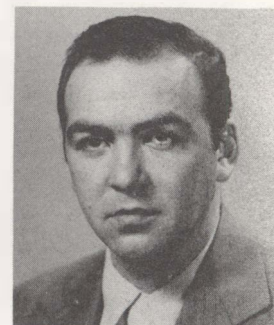
Soil surveys were conducted in cooperation with the Soil Conservation Service and the Bureau of Plant Industry, Soils and Agricultural Engineering of the USDA. Surveys were initiated in Spink and Brookings counties in 1947. Survey crews worked in Spink during the summer and Brookings during the cooler six months.

Crops and soils research projects under irrigation were initiated at the Huron and

Redfield Development Farms in 1948. Since there were no funds allocated for the work, various project leaders had to bootleg time and resources from existing projects for the research.



F. C. Westin



G. J. Buntley

Worzella initiated a pasture research program and in cooperation with members of the Animal Husbandry Department, cattle were grazed on several pasture mixtures at the Huron Development Farm from 1948 to 1950. The following year Hereford steers grazed several pasture mixtures on the east half of the "Olson Eighty" across the road from the Agronomy Farm at Brookings. The experiment, which was terminated in 1955, was replaced by a second 5-year experiment at the same location.

The 1949 Legislature appropriated another \$400,000 for Agricultural Hall (K-102).

Raymond Walz was added to the Agronomy Department as an assistant in the seed Laboratory in 1949.

Burton L. Brage was added to the soils staff in 1950, primarily to assist with teaching the increasing number of students and soils courses. He also conducted soil fertility research in Western South Dakota.

New Varieties

The crop varieties developed by C. J. Franzke were released in 1945. Rancher, the second of two low-prussic-acid sorghum varieties, and Ree wheatgrass were released through the Foundation Seed Stock Division and County Crop Improvement Associations.

Feebar and Plains, two barley varieties developed by S. P. Swenson and J. E. Grafius, were released through the FSSD and County Crop Improvement Associations in 1947 and 1948.

In 1948 the FSSD produced 4,800 bushels of Rushmore wheat, developed by Grafius, and 400

bushels of Hawkeye soybeans. The seed was distributed in 1949 (JW-57).

In the spring of 1950, 85,000 pounds of James hullless oats, developed by Grafius, were distributed to County Crop Improvement Associations. It was enough seed to plant 17,000 acres. Other seed distributed by the FSSD included 900 bushels of Moore barley, 160 bushels of Capital soybeans and 3,700 pounds of foundation seed of Ranger alfalfa. Pierre rye, developed by Grafius and Dirks, was distributed that fall (JW-60).

Twenty thousand pounds of homesteader smooth brome grass, developed by J. G. Ross were released in 1951.

One thousand bushels of Dupree and 1450 of Waubay oat varieties, developed by V. A. Dirks, were distributed to registered seed producers in 1954. It was believed that the varieties had limited areas of adaptation and they were named for towns in the areas where they would be most suitable.

SDCIA Programs

The directors of the SDCIA became concerned over future expansion of the FSSD. In 1949 William P. Peterson of Lily recommended that steps be taken to purchase land to be used exclusively for the production of foundation seed where problems of soil fertility and weed control could be handled more satisfactorily (JW-58).

Also in 1949, the board of the SDCIA recognized the needs for enlarged facilities for seed and soil testing, personnel for grass and legume breeding, variety performance testing and the need to initiate pasture and irrigation research (JW-58).

The 1949 Legislature appropriated \$50,000 for equipment in the Agronomy Seedhouse and the Greenhouse (K-102) which was completed in 1949.

The board of directors of SDCIA showed considerable interest in a means of increasing research in crops and soils and reducing the time required for benefits of research to reach the farmer. In February of 1950, the board met with Dr. Fred Leinbach, President of State College, with these objectives in mind and suggested the following means of approaching the objectives (JW-59).

1. A crops and soils service building for seed laboratory, soil testing laboratory, seed certification, soil survey and weed work
2. An expanded state-wide variety performance testing program

3. Pasture investigations
4. Irrigation studies in anticipation of increased irrigation in connection with the Missouri River Development Program
5. Plant breeding in oil crops
6. Additional land for experimentation and increase of new crop varieties
7. A seed processing and cleaning plant for the Foundation Seed Stocks Division.

President Leinbach agreed with the objectives but indicated that the budget of the College could not finance these requests. Since these suggestions were not included in the college budget, the legislative committee of SDCIA decided to sponsor a special bill to secure these needs (JW-59).

E. G. Sanderson was selected to serve as a lobbyist at the 1951 legislative session (JW-59). During the session the Association was extremely active in attempting to secure special appropriations for the terms outlined in 1950. Added to these items was a Plant Pathology Greenhouse and higher salaries (JW-61).

Agronomy Weathers First Storm

The right of the SDCIA to advocate appropriations for the development of crops and soils facilities at State College was challenged by those who did not welcome its support (JW-62). Several seedsmen, for example, objected to the Foundation Seed Stock Division. Before its establishment seedsmen were able to secure small amounts of seed, increase it and sell seed of the new variety. However, the FSSD increased the small amounts of seed and sold it directly to SDCIA members, some of which were seedsmen.

The 1951 Legislature did not provide any new facilities for Agronomy but did appropriate another \$125,000 for Agricultural Hall (K-102).

The length of the work week was shortened from 48 hours to 44 hours, with Saturday afternoon off.

A damaging storm developed in the spring of 1951. On March 7, the Regents approved Leinbach's recommendation that the Agriculture Division be reorganized in the interest of what he deemed greater efficiency. At the same time he tried to get the Regents to dismiss the Directors of Experiment Station and

Extension Service and the Head of Agronomy, whom he accused of lack of cooperation and of "insidious and underhanded activities" against the administration (S-37).

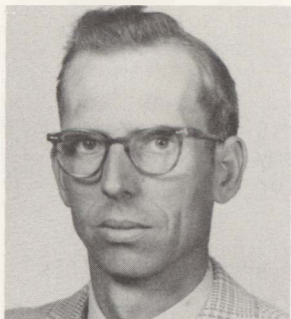
The three alleged obstructionists had strong support among farm groups in the state. They were accused of giving information and ideas to these groups, which had caused the Legislature to give priority to their projects rather than to requests from the College administration (S-37). A public Regents meeting was held in at Slagle Auditorium at the University of South Dakota on April 14, 1951, in which both sides stated their cases (S-37).

A. M. Eberle, Dean of Agriculture, had aspirations of also being Director of the Experiment Station and Extension Service and sided with the President.

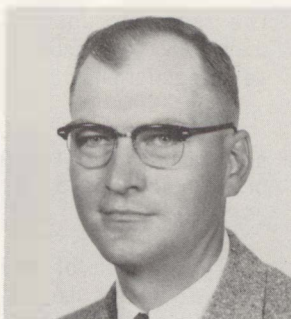
On April 20, 1951, the Board of Regents met in Huron and studied the transcript of the "hearing". The next day, it decided to rehire the persons that Leinbach wished to dismiss. At the Aberdeen meeting of the Regents on May 18, President Leinbach submitted his resignation effective July 1, 1951, or as soon thereafter as was convenient for the board (K-109 & 110).

More New Programs

Fred E. Shubeck joined the soil survey group, primarily to perform soils investigations on various soils associations to determine the soil fertility and management needed for each--an approach suggested by A. N. Hume in 1912. Since fertility research work was done during the summer, Shubeck joined the survey party in Brookings County during the winter.



B. L. Brage



F. E. Shubeck

The year 1952 found a new President, Dr. John W. Headley, at South Dakota State College who was vitally interested in the SDCIA legislative goals and the SDCIA. He was deeply concerned about faculty salaries and sought the support of farm groups (JW-63).

Headley's system worked. Appropriations for State College were increased 25% in 1953, another 20% in 1955 and still another 50% in 1957 (K-126).

The Agronomy Department moved into Agricultural Hall in August 1952. Originally Agronomy was to have the entire second floor. However, as moving time approached, Dean Eberle decided that the Department of Economics, a relatively large department, would occupy the east half of the south wing. Even so, the facilities were a great improvement over the previous accommodations.

Most offices held two staff members. All Teaching, Research, Statewide service and Extension personnel were in the same proximity for the first time.

Grafius resigned in 1953 and was replaced by Dale D. Harpstead.

During the 1953 legislative session, the efforts of the President of State College, supported by farm groups made progress toward the goals set up in 1950. A \$275,000 appropriation was secured for a Plant Pathology-Botany-office-laboratory-greenhouse complex (JW-64). Approval was also given for the construction of the Foundation Seed Stock Division building on state owned land. Both units were completed in 1955.

Worzella was the first Chairman of the Graduate School. In 1953 members of the Agronomy Department agreed that they could provide a curriculum for a Ph.D. degree if adequate courses in plant physiology, soil bacteriology and statistics could be provided by other departments. At that time, no one at SDSC was well trained in those subjects.

The granting of Ph.D. degrees in Agronomy, Animal Husbandry and Agricultural Economics was authorized by the Regents in 1954 (K-119). These were referred to as Plant Sciences, Animal Sciences and Social Sciences in the catalog for 1954-1955 (K-127). In 1959 A. Earl Foster, under the supervision of J. G. Ross, received the first Ph.D. granted by SDSC.

The program also allowed a student to transfer one year of graduate study to SDSC. Staff members who were SDSC graduates were encouraged to use this program. Donald E. Kratochvil, who had obtained B.S. and M.S. degrees from SDSC, took a sabbatical leave in 1958-1959 to attend the University of Nebraska. Under the supervision of D. B. Shank, he received a Ph.D. from SDSC in 1961. He was the first Agronomist and perhaps the first person to obtain a degree in this manner.

Appropriations from the 1955 Legislature included funds for establishing three Mobile Research Farms. The farms were used to study crops and soils problems for a 5-year period in different areas of South Dakota. Farms were established at Menno, Presho and Watertown.

The Menno and Watertown sites were chosen that summer. Edward J. Williamson secured equipment and laid out the plots at the Menno and Watertown locations before he resigned in October 1955. Quentin S. Kingsley operated both farms. He also established the farm at Presho in 1956. Starting in 1957 it was operated by Harry A. Geise.

The Menno Farm was replaced by the Southeast Experiment Farm in 1960 and the Presho Farm was closed in 1973. The Watertown Farm served as a base for two other Research Farms and at this writing is still in existence.



Q. S. Kingsley

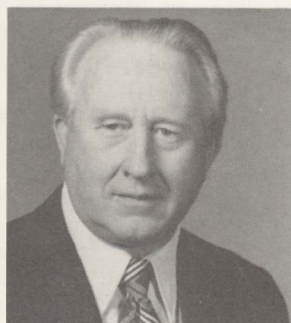


H. A. Geise

During 1956 and 1957 Worzella secured the services of two USDA employees; Dr. Charles R. Swanson, alfalfa physiologist, and Dr. Phillip B. Price, barley breeder.



D. D. Harpstead



P. B. Price

Jack R. Runkles was employed as the first soil physicist in 1955.

B. J. Brage was selected as one of the two outstanding teachers at SDSC in 1955 and shared an award of \$1,000. D. E. Kratochvil won the award of \$1,000 in 1957.

A. O. Syverud succumbed to cancer in July 1956 and G. Dwight Johnson retired from the Seed Certification Service. G. W. Erion was promoted to Manager of FSSD. J. Duane Colburn was employed in 1957 as assistant manager, in charge of forage seed increase, and manager of the Seed Certification Service.

Also in 1956 R. A. Moore was employed as a teacher to fill the gap left by Webster who became Assistant to the Dean. Moore later took charge of the pasture research program then served as Department Head for 4 years before becoming Associate Dean and Director of the Experiment Station.



J. R. Runkles



W. C. Moldenhauer



J. D. Colburn



R. A. Moore

Congeniality and Conviviality

Staff members were young, enthusiastic, talented and congenial. Less than 5 years separated the ages of most of those that were employed between 1946 and 1951. Most were World War II veterans, fresh out of graduate school with young children. Wally Worzella let them develop at their own pace and Hazel mothered the young wives. For several years she prepared and served a dinner to a dozen or more as a reception for each newly arrived family.

Then there were the fishing trips, pheasant, deer and antelope hunts, the summer picnics,

the Christmas parties and the Fourth of July fireworks displays. In addition to these "fun" activities, there were numerous other amusing incidents.

During the years of the peak pheasant population a dozen or so staff members and graduate students congregated at the Agronomy Seedhouse, divided into 4- or 5-man teams and set out to hunt pheasants. After a few hours they reconvened to see which team had the most birds. During the fall of 1950, permission was obtained to take and store several hundred birds to serve at a dinner when Agronomists from the North Central States convened at SDSC the next summer. Dale Harpstead summed up one hunt by saying, "Can you believe that I LEGALLY shot 19 birds one afternoon?"

Several used to razz Derscheid because he painted all his sprayers and tools orange. The orange color made tools easier to find when laying in green grass or in the tool box belonging to someone else. He was supposed to help register the visiting Agronomists in 1951, but instead took Bonnie to the hospital where she gave birth to their third child.

A tour of the Agronomy Seedhouse was scheduled during the Agronomy meeting. Several staff members were ready to show their equipment etc. Lyle went to the corner where his orange sprayers were parked only to find that John Grafius had parked an orange baby buggy between the sprayers.

Each year a half dozen or so went deer hunting in the Black Hills. One year Kathy Williamson suggested that she would like to spend the same amount of money on herself that Ed would spend on the hunt. Ed argued that he wasn't spending much when the value of the meat was considered. "Yes and we just love venison, don't we?" was her reply.

On another hunt Chuck Stahler, Wally Worzella, Larry Fine, George Buntley and perhaps one or two others, bagged a deer or two on the first afternoon. They returned to the cabin and decided to have deer liver for supper. The liver had barely started to fry when it began to emit the most awful odor. Everyone but Buntley claimed that George had released the bile all over the liver. They could substitute canned hash for the meat, but there was no way to avoid the stench. It was cold outside.

One Saturday morning Don Kratachvil and Jim Hay went to White to work on quackgrass plots which were located near a duck slough. They took a shotgun or two along just in case. One gun discharged at the wrong time and blew a hole in the gas tank of the 1947 Ford pickup. When Don called Wally to report the incident,

Wally said, "I'll bet that no one will ever know it happened by the middle of next week." He was right; some of Dorothy's grocery money was missing, but the pickup was soon good as new.

Vic Dirks and his German Shephard were inseparable. While Vic worked on plots, Volff chased rabbits or whatever. On a trip to Newell, Volff met a skunk for the first time. The skunk was the antisocial type. While homeward bound Volff stuck his head out the rear window of the station wagon but Vic had to stay inside with all that "pew".

On the Fourth of July each family brought an assortment of fireworks to the Agronomy Farm and took turns entertaining young and not so young alike.

After eating the bountiful Christmas potluck dinner, Ray Kinch or Clarice Shank led the group singing of Christmas Carols. They never finished "Jingle Bells". Every time they came to the chorus, bells started to jingle and Santa Clause came through the door. With help from older children he delivered the presents that parents had brought for their children.

There were presents for the adults too. Jack Runkles, for example, received a crying towel, complete with poem by Harpstead and Derscheid bemoaning the fact that King Hill and his Rice Team mates had defeated John David Crow and the Texas Aggies. Bonnie Derscheid received a citation to commemorate the ticket she received for going through a caution light.

With a skit featuring Dale Harpstead in Wally's deerskin jacket, Worzella was reminded that he had arrived for the departmental stag, wearing the jacket, one week early. "Is this the night?" he asked. "Right night but wrong week" was the reply. Santa gave Derscheid an egg cup after Frankie Ross, a Canadian, learned that Lyle didn't know how to use one when he was in England.

Everyone paid a nickel for a cup of coffee in the coffee room. Each year the profit was prorated. The secretaries had their party and the men had a stag in Derscheid's basement. They played pool, ping pong, poker, bridge, whist or cribbage. The money was used for refreshments. After the first party in 1956, Derscheid found cans on the floor joist bracing and the sills. Bonnie noticed a dusty footprint on a kitchen chair and looked up to find a can perched on the door chimes. Someone with a foot the size of Burt Brage's had gone upstairs to the bathroom. The next year the ceiling was tiled and a bathroom was installed in the basement.

The stag was held every year but three since its beginning. During later years Duane Colburn, business manager for the stag, brought rib eye steaks. At 10:00 o'clock, the charcoal in the fireplace was started and everyone cooked his own steak.

Another Storm

For over a decade Agronomy had received the food it needed for a rapid healthy growth. Money, an essential element of growth, had been adequate to provide much improved facilities and an expansion in personnel. The young staff members possessed an abundance of talent, enthusiasm and dedication.

However, storm clouds that started to form in 1952 and 1953 hovered over the unsuspecting department for several years. The storm increased in intensity in 1956 and descended in full fury a year or so later. It dealt a destructive blow to Agronomy.

In April 1953 the Board of Regents authorized a new position with the title Chief, Division of Agriculture, a position that would be comparable to an Administrative Vice President in charge of all Agricultural activities (K-116).

Dr. Ephriam Hixson assumed the position on November 1, 1954 (S-119). A few months later, he expressed dissatisfaction with staff response and with the housing provided (K-121). Several of the staff with whom he was dissatisfied were scheduled to retire soon because they would reach the age of 65.

In April 1957, President Headley relieved him of his duties as Chief, Division of Agriculture and named him Dean of the Graduate School (K-122).

In August Hixson submitted his resignation (K-122) and issued a 42-page report in which he contended that there were seven people at State College whose elimination would make it a fine institution (S-39). The seven people included the President, the Dean of Agriculture, Director of Extension, Head of Agronomy, Extension Animal Husbandman, an Extension Supervisor and a County Agent.

The Board of Regents solicited written statements from whomever wished to prepare them, reviewed the statements on November 8 and 9 and held a hearing on the campus of SDSU, November 11 to 16, 1957 (K-124).

Later in the month President Headley died in a hunting accident.

Then the State Auditor decided to audit the books of the Agronomy Department. He was es-

pecially concerned with the Foundation Seed Stocks Division and severely criticized Worzella for the way the funds were handled. He failed to accept the fact that policy was developed by the FSSD board which included the college president, the administrators in agriculture and five farmers.

Worzella was also criticized for improper use of weed research funds. The auditor refused to believe, for example, that the purchase of a plot thresher was a legitimate purchase for weed control. He did not believe it necessary to thresh yield samples for hundreds of small grain plots grown on weed research farms and at Brookings to determine the effect of herbicides on crop yield or to determine how much yield was increased by controlling noxious weeds.

The Board of Regents issued a report in January, 1958. It stated in part "Matters concerning Hixson and Headley were moot since Hixson had resigned and Headley was dead. A. M. Eberle and G. I. Gilbertson, Director of Extension, were part of the problem, but since they would retire June 30, 1958, because of age, nothing was done about . . . Worzella was to be fired immediately, but was to be paid until June 30, 1958" (K-125).

Farmer groups banded together and formed the "Organization for the Advancement of Agriculture, a non-political organization with no political motive". It was headed by a seven-man committee composed of farmers from seven areas extending from Jefferson in the southeast to Selby in the north central part of the state.

The organization prepared and distributed a pamphlet. Its contents included parts or all of some editorials from the *Hamlin County Herald-Enterprise* of Hayti.

Excerpts from the Pamphlet

Last week the Board of Regents arrived at some queer conclusions anent the long-simmering State college controversy precipitated by Dr. Ephriam Hixson last summer. It is recalled that Hixson, disappointed because control of the Agricultural Division, apparently promised him when he joined the staff, did not materialize, loosed a blast of blunderbus charges which accused certain individuals of such imponderables like thought control and suppression of academic freedom. But here is the queer manner in which the Regents disposed of the matter, which is particularly startling in view of the fact that it was supposedly acting in an impartial fact-finding capacity. Actually the result heightens an impression that the board was really embarked on a definite, pre-arranged program in which a goat had been predetermined from the beginning. Here are the steps it took.

Analyze them and decide whether they are the considered actions of an unbiased body.

First it fired the one man whose competence and fitness for his post are proved; a man who commands national acclaim for his scientific ability; and a man of the type South Dakota constantly seeks--usually in vain. Next, it coldly maligned with qualified praise, the now deceased SDSC president, no longer here to defend himself. Then in Hitlerian gesture, it summarily ordered extension agents to keep their mouths shut. And finally, as a crowning insult, it demanded that the public forget the mess, allow peace and quiet to descend. Obviously it did not desire the issue debated. But that is just what should occur. There are many mystifying points to clear up; among them something more specific than the mere sayso of the board that Dr. Worzella, who was summarily discharged, was incompatible and insubordinate. In view of the conclusions it reached it is conceivable that the regents board would seek peace and quiet; certainly its findings will never stand the heat and hard scrutiny in public debate. Criticism already is mounting and perhaps before the final rumblings pass beyond the horizon the board will welcome in desperation a seat on a hot South Dakota ant-hill as the very quintessence of peace and quiet by contrast.

Like most laymen, the editor had been disposed to credit the Board of Regents with sincerity in its efforts to clear up the dispute precipitated by Dr. Ephriam Hixson last summer. But its final disposition of the case that resulted in the summary discharge of Dr. Worzella, Head Agronomist, for no good apparent reason, and then its almost hysterical insistence that the public refrain from criticism or speculation placed a rather different aspect on the picture. The admonition of silence in the face of the derogatory comments anent Dr. Worzella, Dean Eberle and George Gilbertson recalls a statement printed in gold upon a huge banner that stretched across the meeting hall of the Farm Bureau Federation at its 1957 convention. The scroll read: "All That Is Needed for Evil to Prevail Is for Good Men to Do Nothing." That would seem to apply in this instance with telling accuracy. For the reflections left by the board in its ruling in the matter are as mean an injustice as ever applied to a group of men. And if the final decision is permitted to stand unchallenged every South Dakota farmer is destined to suffer in purse and progress because of it.

Dr. Worzella is an upright individual, and a recognized leader in his field, dedicated to the service of South Dakota; and a man, moreover, adamant in his championship of the South Dakota farmer. Actually it is this that got

him and his compatriots into their present difficulties. What many people do not appear to realize is that the present controversy is merely a continuation of a long struggle that flared up briefly in the Lienbach incident seven years ago. Now, as then, the basic issue at dispute is the insistence of a certain element upon restriction of the Foundation Seed Stock Division. They would permit commercial seed interests to exploit commercially the new varieties and improvements developed by the Agronomy Department, a shift that has been resisted vigorously all along by Dr. Worzella, and others. It would remove the present arrangement whereby South Dakota farmers themselves develop their own foundation stocks through the local crop improvement associations--an arrangement that has kept them abreast of progress at relatively low cost for foundation seeds. If this were abolished now and the exploitation turned over to private interests the farmers unquestionably would pay through the nose for the new seeds.

The selfish interests, it is recalled, were roundly trounced in the Lienbach incident, but evidently they kept at it and finally pieced together a new sure-fire scheme to achieve their ends. In the cabal thus aligned against the farmers of the state we find now the acting president at State, Dr. H. M. Crothers, and the Regents board membership, individually and as a body. Dr. Crothers, it is recalled, was an active partisan in the Lienbach affair, and had made no bones as to his personal antagonism to Dr. Worzella at the star chamber hearings conducted by the board for stage dressing purposes.

Maybe some are willing to accept generalizations of the board members in the dismissal of Dr. Worzella rather than definite facts. The public is entitled to all the facts, not merely the say-so of a handful of scheming regents members or a biased acting executive officer at State. Comparison of the testimony with the findings would indicate that the investigation itself was pretty much a farce; that the Board already had reached its decision before it began. Of the 30-odd witnesses who appeared none involved the Agronomist flatly or spontaneously. In most cases, reluctant assent was elicited by Regent Eggen who carried the burden of the inquisition and appeared determined on associating Worzella with every questionable situation. Once he had that, or a passable facsimile, he desisted.

The unreal nature of the investigation is emphasized further when we look into the Hixson Report that precipitated the affair. The Report, with its scurrilities and character defamations, none documented, unques-

tionably rates Dr. Hixson, no matter what his stature as an educator, as a blatherskite of the meanest order. And nothing reflected his blatherskitism more emphatically than the recently turned up change in his original report. One would think that so long as the Hixson scurrilities actually sparked the Regents investigation, that body would go through the whole thing objectively--first to document the charges, if possible, and, failing that, to restore the good names of the people who had been unjustly maligned. But the board did none of these things. It never glanced at a charge of fiscal fenagling in one department, or of alleged intoxication on the part of a 4-H club leader. None of

this interested the board; it was in full bay after one marked individual, and would not be turned aside.

PLATEAU OF GROWTH IN AGRONOMY 1958-1969

In January 1958, members of the department decided to elect a 3-man committee to perform the administrative duties. L. O. Fine was elected chairman with M. W. Adams and Lyle A. Derscheid as the other members. Fine was appointed Acting Head by Acting President Crothers. On July 1, 1958, Fine was appointed as the third Department Head and he served for 11 years.

Research and Teaching Staff

Members of the teaching and research staff who were in the department during the entire 11-year period include Fine, Shank, Kinch, Westin, Ross, Carson, Erion, Shubeck, White, Kingsley, Moore, Colburn, Price and Geise. Members with rank of Instructor or above, who either left the teaching and research staff or joined it during the period, are listed below:

Clifford J. Franzke	7/1/24-10/64	Sorghum breeding
Dr. Leo F. Puhr	7/1/27-10/1962	Soils
Dr. Lyle A. Derscheid	3/16/46-6/30/64	Weeds
Victor A. Dirks	5/1/47-1961	Wheat and Rye breeding
Dr. Donald E. Kratochvil	8/1952-1960	Asst Corn and Teaching
Dr. George J. Buntley	7/1950-6/1968	Asst Soil survey
Dr. Dale D. Harpstead	8/1/53-1961	Oats and Flax breeding
Dr. Jack R. Runkles	1955-1963	Soil physics
Wayne G. Wright	6/1957-12/1966	Seed Lab, FSSD, Weed
Dr. Donald G. Kenefick	7/1959-	W. Wheat physiology
Dr. Dwight R. Hovland	1960-1970	Soils
Dr. C. Dean Dybing	4/4/60-	Flax physiology (USDA)
Dr. Melvin D. Rumbaugh	1960-1977	Alfalfa breeding
Paul D. Evenson	1961-	Soils
Edward J. Langin	1961-1962	Asst Soil testing
Wilford H. Wallace	1960-1962	Asst Weeds
Earl A. Monnens	1961-1962	Asst Soil survey
Robert D. Heil	1961-1964	Asst Soil fertility
Zane F. Lund	1961-	Irrigation
Dr. Durwood O. Beatty	1961-1967	Asst Corn and Teaching
Joseph J. Bonnemann	9/1/61-	Performance testing
Dr. Rulon Albrechtsen	1962-1969	Oats and Flax breeding
Dr. Darrel G. Wells	2/1/62-	W. Wheat breeding
Dr. Raymond C. Ward*	1962-1972	Asst Soil testing
Dr. Lloyd C. Warner	1962-1964	Asst Weeds
Dr. Tamlin C. Olson	8/1963-8/1973	Soil Conservation (USDA)
Dr. John Dosland	1962-1968	Asst Weed physiology
Dr. Chen Ho Chen	10/1/63-8/30/64	Post Doctorate
Dr. Jimmy Stritzke	1965-1969	Weeds
Dr. Maurice L. Horton	6/1964-3/1973	Soil Physics
Dr. Allyn O. Lunden	1964-1976	Sorghum breed, Seed Lab
Dr. Charles Frazee	1969-1974	Asst Soil survey

External Changes

Numerous changes made by the Board of Regents, Governor or State Legislature caused changes at SDSC and the Agronomy Department.

In 1959 the Legislature made Statewide Services a part of the Agricultural Experiment Station. A year or so later Governor Gubberud shortened the work week for 12-month employees from 44 to 40 hours.

Beginning in 1961 money made available for the public colleges by the Legislature was labeled General Appropriations and Continuing Appropriations. The Continuing Appropriations were merely authorization for the colleges to spend the funds called "local and endowment" which were made up of tuitions, fees, rentals, and miscellaneous institutional income. The label Continuing Appropriation was dropped when all L and E Funds (Local and Endowment funds) were taken over by the Legislature (K-143).

At first this created a budget problem for the Agronomy Department. Not only were L and E funds taken over by the Legislature, but so were E and S funds which came from the sale of crops raised on research plots and the sale of cattle from pasture studies. The Seed Testing Laboratory and Soil Testing Laboratory were largely financed from fees charged for services rendered and the Foundation Seed Stock Division operated entirely on funds obtained from the sale of seed. Initially it was mandatory to forward all of this revenue to the General Fund at Pierre. However, it was soon possible to set up revolving funds for such activities as the seed and soil laboratories, pasture research project and others.

The school year was changed in 1961. The Board of Regents decided that all seven state supported institutions should have the same system. The University of South Dakota and one other college had the semester system and the Board decided that the other five institutions should change from the quarter system (K-143). Such a change had been discussed by SDSC faculty on several occasions. Each time it was voted down. This meant a complete change in all curricula. Initially many 3-hour courses remained unchanged except that they became 2-hour courses.

Beginning in 1963 the Legislature authorized holding annual sessions so that college budgets henceforth would be developed annually instead of biannually (K-143).

The name of the college was changed. After being an Agricultural College, a State College of Agriculture, and a State College of Agriculture and Mechanic Arts, it became a State

University. This change in name to South Dakota State University was authorized by the 1964 Legislature. (K-143).

Staff Changes

Most Agronomists were deeply depressed by the way the Board of Regents had treated Worzella. He was well liked and well respected and his discharge was an unjust reward, they felt, for energetic dedicated service. Needless to say, many lost their enthusiasm and several discussed the possibility of leaving SDSC. J. G. Ross obtained a Guggenheim Fellowship in 1958 and spent a year in Sweden and M. W. Adams resigned in December to take a position at Michigan State University.

B. L. Brage was appointed Director of Resident Instruction of the Agriculture Division in 1959, but continued to teach some soils classes for several years.

Also in 1959, the North Central Regional Winterhardiness committee received funds from the USDA to employ a staff member. J. E. Graffius, the Michigan representative on the committee, suggested that a physiologist be located at SDSC to investigate winter hardiness in winter wheat. D. G. Kenefick was employed July 1, 1959.

F. C. Westin accepted an appointment from the Foreign Agriculture Organization of the United Nations in 1959 and spent a year, 1959-1960, as a soils consultant in Venezuela, South America.

L. F. Puhr became ill in 1958 or 1959 and his health gradually deteriorated. In 1960 D. R. Hovland was employed to teach soils classes formerly taught by Brage and Puhr, and M. D. Rumbaugh filled the vacancy left when Adams resigned. C. D. Dybing, USDA plant physiologist, initiated flax physiology investigations. Lyle A. Derscheid succeeded U. J. Norgaard as Extension Agronomist on March 1, 1960. However, he continued to have charge of the weed research project and W. H. Wallace was employed to assist him.

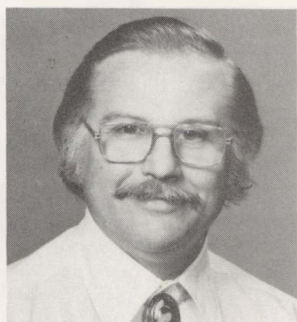


C. D. Dybing

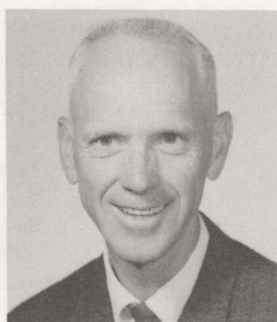


M. D. Rumbaugh

Both small grain breeders resigned in 1961. D. D. Harpstead took a position with the Rockefeller Foundation in Columbia, South America, and V. A. Dirks returned to graduate school. P. D. Evenson, E. J. Langin and R. D. Heil were added to the soil fertility staff headed by P. L. Carson. Langin supervised the Soil Testing Laboratory and Heil assisted with soil fertility experimentation. E. A. Monnens was added to the soil survey staff, D. O. Beatty filled the vacancy left by Kratochvil and J. J. Bonnemann moved from Newell to take charge of the Variety Testing Program.



P. D. Evenson



D. G. Wells

Five new staff members were employed in 1962. R. Albrechtsen and D. G. Wells became the new small grain breeders replacing Harpstead and Dirks. R. C. Ward replaced Langin who resigned to take the Extension Soil Specialist position vacated by E. J. Williamson and L. C. Warner replaced W. H. Wallace on the weed project. In 1961 the U.S. Congress made a special appropriation for weed control by Agricultural Experiment stations. South Dakota's share was \$8,500. John Dosland was employed to study the physiology of leafy spurge root growth and development.



J. J. Bonnemann



R. C. Ward

Dosland joined Kenefick and Dybing in their new quarters. The plant physiology laboratory was moved from room 209 of Agricultural Hall to the first floor of the "Old Dairy Building."

Leo Puhr passed away in October, 1962 after a lengthy illness.

Tamlin C. Olson took charge of the Soil and Water Research Farm at Madison in 1963 and Jack Runkles resigned to take a similar position at Texas A & M University. M. L. Horton replaced Runkles in June, 1964. The next year Heil resigned and Warner was discharged.



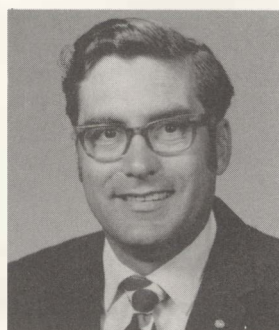
D. G. Kenefick



M. L. Horton

G. W. Erion was in India during 1963-1964 as a consultant for the formation of seed distribution and certification programs.

W. G. Wright, who had been an assistant in the Seed Laboratory, managed the Foundation Seed Stock Division during 1963-1964. In July of 1964 he replaced Warner on the weed project. Derscheid left the weed project June 30, 1964. A. O. Lunden became the new sorghum breeder in the fall of that year.



T. C. Olson



A. L. Lunden

New leadership was obtained for the weed project. Jimmy Stritzke took charge in 1965. A year later his assistant, W. G. Wright, resigned and C. E. Stymiest was employed as an "Assistant in Agronomy" to assist with weed research.

In 1966 G. J. Buntley resigned from the soil survey staff to take a position at the University of Tennessee.

D. O. Beatty resigned in 1967 to take a teaching position in Kentucky. Dr. Fine submitted a 1968 budget with a salary for a successor to Beatty. However, Dean Acker deleted the position and reallocated the money for the position to other staff members without consulting the Department Head. The position was never filled. Also in 1968 the weed physiology position was terminated, Dosland was discharged and the position was permanently discontinued.

New Varieties

The fifth sorghum variety developed by Franzke was released to County Crop Improvement members in 1958. Dual was the first dual-purpose variety that could be used for grain or forage.

SD 102, a grain sorghum variety, and the first sorghum hybrids developed in South Dakota were released in 1959. Crop Improvement members had difficulty raising seed of SD 441 and SD 451. A year later Sokota Hybrid Producers arranged to produce and market the seed of both hybrids. Also, 125 pounds of Foundation seed of Teton, the first pasture-type alfalfa, were released to County Crop Improvement Associations. It had been developed by M. W. Adams and G. Semeniuk of the Plant Pathology Department.

Grain sorghum SD 100, a parent of hybrids SD 441 and SD 451, was released as a variety in 1960. Grain sorghum hybrids SD 502 and SD 503 and the dual-purpose hybrid SD 252F were released in 1961. Sokota Hybrid Producers made plans to produce and market the hybrids.

J. G. Ross released Oahe, a new variety of intermediate wheatgrass, during 1962 and Summer, a variety of the warm-season switchgrass in 1963. Travois, another pasture-type alfalfa developed by M. W. Adams, M.D. Rumbaugh and G. Semeniuk, was also released in 1963.

Albrechtsen finished the development work started by Harpstead and released Ortley oats and Summit flax in 1963 and 1964, respectively.

C. J. Franzke, released Winner, a short-season variety of grain sorghum before he retired in 1964.

Hume, the first winter wheat variety developed in South Dakota, was released the fall of 1965 by D. G. Wells. It was one of the few varieties resistant to race 56 of stem rust that caused a \$25 million loss in 1962. J. E. Grafuis made the original cross and V. A. Dirks evaluated it along with many others. Had they remained at SDSC it is possible that a sizable acreage of Hume would have been planted in

1962. The loss in 1962 could have been reduced.

About 800 bushels of Primus, an early barley variety developed by P. B. Price, were released to County Crop Improvement Associations in 1967. It contained some off-type plants. During the next 2 years they were removed and 4,000 bushels of Primus II were released in 1969. Kota oats developed by Harpstead and Albrechtsen was also released in 1969.

Winoka winter wheat, developed by D. G. Wells, was released to County Crop Improvement Associations during the fall of 1968. It was selected from the Canadian variety, Winalta, which contained both white- and red-chaffed strains. The white-chaffed strain was resistant to race 56 of stem rust. It was increased, named Winoka, and released.

Other Changes

The Mobile Research Farm at Menno was closed, as scheduled, in 1960. It had been in operation for 5 years.

In the meantime, the Southeast South Dakota Experiment Farm Association, which was incorporated in 1956, had been selling shares over a 13-county area. The association purchased a farm near Beresford and Centerville and the Agricultural Experiment Station agreed to conduct research on soil fertility, crop production, drainage, erosion and feeding of livestock. It accepted responsibility for the farm on March 1, 1961. Research projects were initiated that year.

In 1962, Dean O. G. Bentley wrote, "The Variety Test Program is a new service function initiated during the biennium. Its purpose is to carry variety tests on a fee basis to determine the adaptability of commercial varieties of commercial crops offered for sale in South Dakota where such information is desired. An attempt is being made to run the program on a cooperative basis with the seedsman and seed-producing companies to the mutual benefit of the trade and the farmers" (K-137).

In 1964, the South Dakota Wheat Commission provided funds to build the plastic covered Greenhouse used primarily for winter wheat breeding. Also in 1964, after several years of deliberation, it was decided that crops and soils research would be discontinued at Cottonwood.

The Cottonwood Substation was not a good location for Agronomic research. The Pierre clay soil of the South Farm was lighter and more easily worked, especially when wet, than the Orman clays of the North Farm (NW quarter). The Pierre clay, when tilled pro-

perly become mellow, especially when a good supply of humus was present. Orman clay, like the Pierre clay, was sticky when wet and formed hard clods if tilled. The surface cracked when dry. The soils of East Farm (SE quarter) were more workable than either of the foregoing. In wet seasons it was possible to cultivate first on fields on the East Farm. It was necessary to wait 2 or 3 days longer for the soil of the South Farm to dry and still several additional days before tilling the Orman clays of the North Farm (Bul 312).

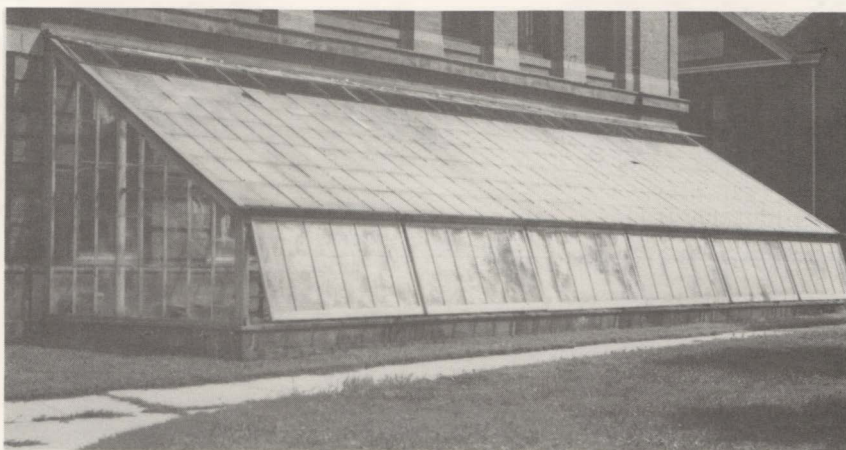
Most of East Farm was being used for long-term grazing studies and was not available for crops and soils research, while the soils on North Farm did not represent a very large area. The rolling topography on most of the station made it difficult to locate areas with sufficiently uniform soil and topography to produce reliable research results. Soils on the slopes and hill tops were thin and those on the lower flat areas were salty and not representative of a very large area.

R. A. Moore obtained a federal grant of \$90,000 for pasture research. In 1965 he established the 2,265-acre Pasture Research

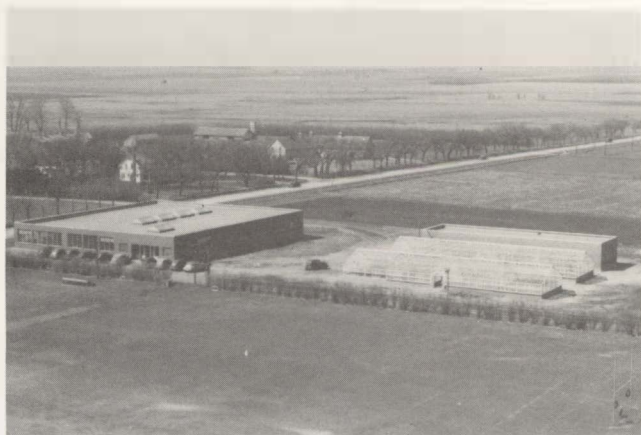
Center in Faulk County and stocked it with 300 Hereford heifers. A 10-year cow-calf study was initiated in cooperation with members of the Animal Husbandry, Economics and Agricultural Engineering Departments.

For several years the possibility of closing the Northeast Mobile Research Farm at Watertown was discussed. It had been scheduled to close in 1960, however, farmers in the area wanted to retain it. Consequently, a West Prairie Coteau Mobile Research Farm was established near Garden City in Clark County during 1965. Kingsley operated it as a satellite from the Watertown farm. All soils investigations were discontinued at Watertown but crop breeding and testing nurseries and weed research were continued.

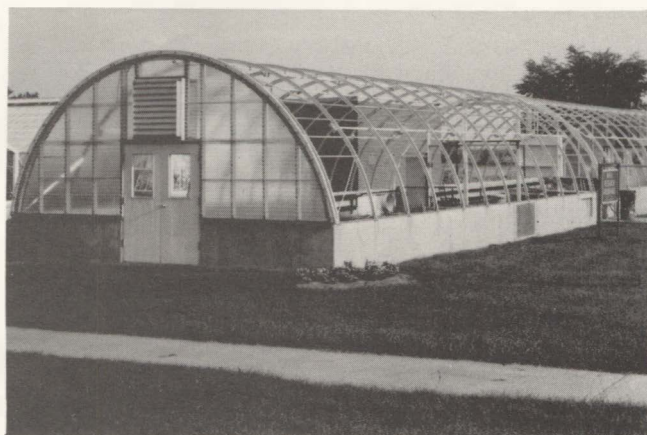
Crop producers in northeast counties complained that research results obtained on the higher elevations of the Prairie Coteau did not apply to the lower elevations of the Whetstone Valley. Consequently, a Mobile Research Farm was established in 1968 near Twin Brooks in Grant County. It, too, was operated as a satellite station from Watertown by Kingsley. Both farms were closed in 1973.



Agronomy Greenhouse during 1930s and 1940s



Agronomy Seedhouse (1947) and Greenhouse (1949)



Plastic Covered Greenhouse (1964)

CHAPTER IV PLANT PATHOLOGY George Semeniuk

Early attention was given to the teaching of Plant Pathology at South Dakota Agricultural College. Plant Pathology, like Agronomy, Entomology and Botany, was taught in agriculture courses by agriculturists and botanists.

Early Experiment Station publications pertaining to plant diseases included four bulletins written by T. A. Williams during the early 1890s, a fifth by D. A. Saunders in 1902 and a sixth bulletin by E. W. Olive in 1909. Arthur T. Evans was listed as an Agronomist-Crops Pathologist in Experiment Station bulletins written from 1921 to 1923.

Walter F. Buchholtz became the Experiment Station Pathologist in 1940 and for all practical purposes was the first pathologist in South Dakota. He came from Iowa and had a research appointment with no teaching responsibilities. In 1944 he brought Clatus M. Nagel from Iowa as an associate. After Buchholtz returned to Iowa in late 1945, Nagel was alone for several years. He was named Department Head in 1947. Under his supervision the size of Plant Pathology increased considerably. The staff included a maximum of 20 persons from 1955 to 1966. Included were nine doctorates, three masters, several assistants and full-time clerical, greenhouse, and field technicians.

Nagel's concern for solving plant disease problems of the state was the driving force in the expansion. He was supported by the Director of the Agricultural Experiment Station, the Dean of the Division of Agriculture, and department heads with whom he interacted. He advised his staff on problems assigned them, supported them in their needs before the administration, and often helped them in field surveys and in the conduct of field and greenhouse experiments. In addition, he managed a corn disease project and developed a number of superior inbred lines of corn. Enthusiasm for and devotion to Plant Pathology continued unabated beyond his retirement as Department Head.

Under Nagel's administration the teaching of Plant Pathology, which had been done in the Botany Department, became a function of the Plant Pathology Department. Teaching curriculum for B.S., M.S. and Ph.D. degrees were developed. The department then participated in the three areas of activity--Research, Teaching and Statewide Services. Extension was added in April 1962 when Leon S. Wood became the first Extension Plant Pathologist.

Nagel resigned as Department Head during the spring of 1969. The department became part of the Plant Science Department July 1, 1969, and Wood became part of the Extension agronomy group on the same date.

EARLY TEACHERS

Thomas A. Williams	1891-1896	Botanist
DeAlton Saunders	1896-1903	Botanist
William A. Wheeler	1904-1907	Botanist
Dr. E. W. Olive	1907-1912	Botanist
C. W. Michel	1913-1920	Botanist
Dr. Arthur T. Evans	1923-1928	Botanist
Dr. E. J. Peltry	1921-1923	Botanist
Dr. Ward E. Miller	1928-1950	Botanist
Dr. Leon C. Snyder	1936-1940	Botanist
Dr. Roland V. Rethke	1941-1943	Botanist
Dr. John M. Winters	1946-1948	Botanist

RESEARCH AND TEACHING PATHOLOGISTS

Dr. Walter F. Buchholtz	1940-1946	Plant pathologist
Dr. Clatus M. Nagel	1944-1975	Department head, 1947-1969
Dr. George W. Bruehl	1948-1952	Cereal rootrot (USDA)
Dr. Lloyd T. Richardson	1949-1951	Potato & Tomato diseases
Dr. John T. Slykhuis	1949-1952	Cereal viruses
Dr. Richard H. Converse	1950-1952	Teaching, Sorghum diseases
Dr. Allyn A. Cook	1952-1954	Septoria leafspot of tomato

Dr. George Semeniuk	1952-1975	Alfalfa, cereal rusts, silage spoilage & root rot
Dr. Cleon J. Mankin	1953-1981	Range grass & sorghum diseases
Dr. Joe F. Hennen	1954-1958	Cereal diseases
Dr. Merle E. Michaelson	1954-1959	Pasmo of flax (USDA)
Dr. Leon S. Wood	1955-1958	Oat diseases (USDA)
Dr. Richard E. Ohms	1955-1957	Cereal root rot
Dr. Herbert G. Pulsifer	1955-1961	Teaching, Stone fruit viruses
Dr. James D. Panzer	1957-1959	Virus diseases
Dr. Fields Caveness	1958-1959	Nematodal diseases
Dr. Frederick E. VanNostran	1958-1961	Action of fungicides
Dr. George W. Buchenau	1959-	Cereal diseases & breeding
Dr. Walter C. Mueller	1960-1960	Virus diseases
Dr. Kenneth Fisher	1960-1963	Fungicides, Sugar beet diseases
Dr. Vernyl D. Pederson	1960-1967	Rhizotonia & pasmo of flax, Barley loose smut
Dr. James M. McQuire	1961-1963	Nematodal diseases
Dr. Gert B. Orlob	1961-1966	Virus disease, wheat streak
Dr. Lester W. Carlson	1963-1966	Potato & Sugarbeet diseases
Dr. Richard B. Malek	1964-1968	Nematodal diseases
Prof. Gerald Thorne	1966-1973	Special appt. on nematodes
Dr. James D. Smolik	1967-	Nematodal diseases
Dr. Wayne S. Gardner	1967-	Virus diseases
Dr. Jack Otta	1969-1979	Bacterial diseases

TEACHING

Initially, courses in agriculture probably included discussions of plant diseases along with topics in other disciplines. However, beginning in 1892 distinct courses, such as mycology with emphasis on plant parasitic fungi, and one or two courses in Plant Pathology were taught. The courses were taught in a department that had several name changes. It was Botany and Plant Pathology from 1911 to 1918, Botany and Plant Diseases from 1918 to 1923, Botany and Plant Pathology from 1924 to 1928, and Botany, Plant Pathology and Bacteriology between 1928 and 1950.

In 1950 the Plant Pathology Department assumed the responsibility for teaching. Staff with more expertise was hired and more sophisticated courses were taught. The Bachelor of Science degree in Plant Pathology was initiated in 1950, Master's in 1952, and the Doctorate in 1955, all in the College of Agriculture.

In 1958 the Bachelor's of Science degree in Plant Pathology was also initiated in the College of Arts and Sciences. Seventeen courses were offered including thesis, seminar, and special problems. The elementary undergraduate teaching program enrolled about 200 students per year after the late 1950s. Enrollment increases began with the introduction of the popular 2-credit hour elementary course "Plant Pathology in Human Affairs", and was

enlarged by higher enrollment in the Department of Horticulture. The success and popularity of the program was largely due to excellent teaching by Converse, Pulsifer, Panzer, Fisher, Buchenau, Mankin, Pederson, Gardner, Smolik and Otta.

Upper level undergraduate and graduate courses were taught by Semeniuk, Mankin, Orlob, Carlson, Malek, Gardner, Otta, Buchenau and Smolik.

DEGREES GRANTED

Degrees granted to students in Plant Pathology are the following:

Bachelor of Science Degrees

James Norman Hauck	1958
Dennis Roy Heifner	1960
Kenneth C. Kruse	1961
Orlando S. Watson	1968
Bruce L. Davidson	1969

Fred L. Bode	1970
Joann Safford	1972
Fred J. Bartling	1972
Steven L. Schwerin	1973
Daniel L. Wendell	1975
Timothy R. Schultz	1976

Master of Science Degrees

Michael Komanetsky	1956
Vernyl D. Pederson	1958

Surindar M. Paracer	1962
Neil E. Martin	1964
Josefino B. Tunac	1968
Gil Cook	1969
Mayo E. Wetterberg	1970
Bruce L. Davidson	1973
Fred L. Bode	1974
Raymond L. Mernaugh	1976
Sandra J. Fryda	1977
Douglas J. Fiedler	1979

Doctor of Philosophy Degrees

Ibrahim A. Al-Sohaily	1961
Gordon A. Nelson	1961
Fazal Rahman	1972
James D. Smolik	1973
Charles R. McMullen	1975
Venance H. Lengkeek	1978

RESEARCH

During early years most of the emphasis was on teaching. Some students were encouraged to pursue Plant Pathology professionally, which a number of them did at other schools. Except by some early botanists, research under the auspices of the Agricultural Experiment Station appears to have been minimal.

Early station bulletins dealing with plant diseases included four bulletins by T. A. Williams: "Notes on Parasitic Fungi observed in Brookings during the Summer of 1891"; "Some Plants Injurious to Stock", which included a section on ergot in grasses and on ergotism in 1893; "Common Fungus and Insect Foes of Farm an Garden" also in 1893; and "Potato Scab" in 1896.

"Treatment of Smuts and Rusts" was written by Saunders in 1902 and "Rusts of Cereals and Other Plants" by E. W. Olive in 1909. Dr. Olive also published studies on rust in *Phytopathology* and in *Science*.

Late in 1920, Dr. A. T. Evans, Professor of Botany at Huron College, was appointed Associate Agronomist-Crops Pathologist by the Agricultural Experiment Station to control wheat rust through the development of resistant varieties. His stay with the project was terminated in 1923 when he was named professor in the Department of Botany and Plant Diseases.

Thereafter there appeared to be no concerted effort to foster plant pathological works within the station until W. F. Buchholtz from the Department of Botany and Plant Pathology of Iowa State College was appointed Plant Pathologist in 1940 to head projects dealing with root rots of cereals and range-land grasses.

The first year Buchholtz was listed with the Agronomy Department, the second as Plant

Pathologist within the Experiment Station, and in 1943 as Plant Pathologist in the Department of Plant Pathology. He had an office and laboratory in Room 119 of the Administration Building and planted experimental plots on West Agronomy Farm, but had no greenhouse facilities.

Buchholtz traveled extensively in the state, learned its plant disease problems, did much to establish a sound basis for research on the control of crop diseases, and laid the groundwork for the development of a department. He identified some of the fungal agents responsible for root rots in cereals and range-land grasses, made similar findings with corn stalk rot, sugar beet root tip rot and sorghum seed rot. He became interested in the control of septoria leafspot of tomato, potato scab, seed rotting, diseases of trees in farm shelterbelts and diseases of horticultural crops.

He realized the need for additional staff and recommended to I. B. Johnson, Director of the Agricultural Experiment Station, that Dr. C. M. Nagel of Iowa State College be appointed Assistant Plant Pathologist January 1, 1944. Nagel was employed initially to develop a variety of septoria leafspot-resistant tomatoes and a strain of cottonwood tree that would tolerate the rust that caused premature defoliation in shelterbelts resulting in winterkill. They shared the same office and research facilities.

Buchholtz resigned in late 1945 to return to the Iowa State College staff.

The Department of Plant Pathology was established in the Division of Agriculture in 1947 with Nagel as Department Head. At that time and until the summer of 1955, the department used a portion of an Agronomy Greenhouse for research.

George W. Bruehl was the first to become associated with Nagel and he was quickly followed by others. This expansion followed the need for additional areas of plant pathological expertise in research and in the accompanying specialties of teaching Plant Pathology at the undergraduate and graduate levels, beginning with the school calendar year 1950-1951.

The staff was cramped for space until the summer of 1952 when it moved to the newly completed Agricultural Hall. It had four offices in rooms 102 through 108, two large laboratories in rooms 101 and 103, and a classroom. These facilities were soon outgrown and the South Dakota Crop Improvement Association convinced the State Legislature to provide funds for larger facilities.

In 1955 the Department of Plant Pathology moved to its newly completed quarters. At the same time it acquired the 30-acre Plant Pathology Farm, located less than 1/2 mile east of the office, for field experiments. It included a field house for storage of field plot equipment, and water was available for irrigation.

Plant Breeding

C. M. Nagel was employed initially to develop a rust-resistant cottonwood tree variety and a line of tomatoes tolerant to septoria leafspot. In 1954 he released the widely-accepted Siouland poplar, a rust-resistant, cottonless poplar with the branching habit of a spruce tree. Gurney Seedhouse, one of several nurseries that marketed the variety, sold 1 1/2 million seedlings. Control of septoria leafspot on tomato proved more difficult.

Diseases of Wheat

Wheat streak mosaic became a menace to winter wheat in 1947. It caused millions of dollars of losses to winter wheat producers until Slykhuis, Hennen, Orlob, Nagel, Buchenau, and Gardner contributed significantly to the biology of the problem and developed a rather simple and unique, but effective control procedure. This involved a change in cultural practice--a delay in planting date for winter wheat.

It was demonstrated in numerous field experiments that a 3-week delay, from mid-August to September 10-14, markedly reduced yield loss by reducing the vector transmission of the virus. Fall temperatures below the feeding temperatures of the vector, the wheat leaf curl mite, *Eriophyes tulipae*, controlled vector activity. Control was thus accomplished without any expense to the wheat grower. Before control measures were known, fields several hundred acres in size became a total loss.

Otta discovered the *Pseudomonas syringae* that caused leaf necrosis in spring and winter wheats. The bacterium was seed borne and widely distributed in the North Central Region of the U.S. He learned that some wheat varieties were resistant to the disease and he implemented a chemical control program for Juniper blight (*Phomopsis juniperovora*) in nurseries.

Buchenau developed an aerial spray advisory system for chemical control of cereal rusts on both winter and spring wheats. Semeniuk studied the take-all and Pythium root rot diseases of wheat.

Diseases of Other Crops

Mankin determined the presence of races of the head smut pathogen (*Sphacelotheca reiliana*) in corn and in sorghum. He determined that the important cause of poor field stands of sorghum was due to extremely fine hairline cracks in the seed coat developed from harvest operations. The cracks presented easy penetration by seed-rotting fungi which could be controlled by seed treatment chemicals.

Otta implemented a chemical control program for Juniper blight, *Phomopsis juniperovora* in tree nurseries and studied methods of controlling canker in cottonwood and Siberian elm trees.

Semeniuk investigated the epidemiology and control of common leafspot, yellow leafblotch and bacterial wilt diseases of alfalfa. Carlson conducted similar studies with *Cercospora* leafspot of sugar beets, while Pedersen conducted similar experiments with Pasm and Rhizoctonia diseases of flax.

The relation between soil populations of Pythium to stand density of newly seeded alfalfa also was investigated by Semeniuk. He and Mankin determined the occurrence and development of *Sclerophthora macrospora* on cereals and grasses in South Dakota and the Northern Great Plains.

Nematodal Diseases

Professor Gerald Thorne, nematologist and professor emeritus, University of Wisconsin, made an outstanding taxonomic study of the plant parasitic and free-living nematodes of South Dakota and the North Central Region. This study resulted in two major publications: technical bulletins 31 (1968) and 41 (1974), "Nematodes of the Northern Great Plains."

Smolik identified as many as 100 soil nematode species in a native range site and discovered plant feeding nematodes consume as much if not more range grass vegetation than cattle. He also identified 40 species in irrigated corn fields. With soil application of a nematocide, he obtained 7-15% yield increases in corn following control of lesion nematodes, 15-34% yield increases in sorghum from control of the stunt nematode (*Tylenchorhynchus* sp.) and the stubby root nematode (*Trichodoyas* sp.) and 20 to 43% yield increases in spring wheat from control of a combination of stunt nematode, dagger nematode, lesion nematode and pin nematode. Lesser yield increases were obtained with other crops. Along with Malek, he also demonstrated the pathogenicity of stunt nematodes to Kentucky bluegrass and implicated the dagger nematode as a factor in the decline of shelterbelts.

Viruses

Slykhuis discovered and named the virus that caused wheat streak mosaic. He learned that it was transmitted by an insect vector. Orlob added to the knowledge about the biology of the transmission of the disease by the wheat curl mite.

Gardner developed a program for students and staff for practical use of the electron microscope for teaching, research and disease diagnosis. He used the microscope to discover the presence and locations of virus and accompanying inclusion bodies in plants. He related the onset of wheat streak mosaic virus in winter wheat to several plant sources and showed that some varieties had some tolerance to the virus. He discovered new plant hosts for several viruses.

Toxigenicities

Semeniuk in cooperation with poultryman C. W. Carlson and veterinarian G. S. Harshfield, determined the toxigenicities of virtually all species of *Aspergillus* to chicks and mice that were fed soybean and wheat diets molded with the fungus. Semeniuk, Carlson, and biochemist J. S. Palmer determined the nature of the growth beneficial effects of certain moldy feeds to chicks.

Gardner showed that air-pollutant effects on plants were widely distributed in South Dakota.

Publications

Research results of the staff were published in scientific journals such as

Phytopathology, *Plant Disease Reporter*, *Journal of Nematology*, several Canadian and European Journals, *S.D. Academy of Science*, *South Dakota Agricultural Experiment Station bulletins*, *S.D. Farm and Home Research*, and departmental pamphlets.

Extension

A limited amount of information about plant diseases was given to farmers by Extension Agronomists and research Pathologists for 2 to 3 decades. It became a permanent part of the Department of Plant Pathology with the appointment of Leon S. Wood as Extension Plant Pathologist in April 1962. He was the first Extension Plant Pathologist at SDSC and continues in that position.

He had been on the Department's research staff from 1955 to 1958 with the Division of Cereal Crops and Diseases, USDA, conducting research on oat diseases.

With assistance from C. J. Mankin, he identified plant diseases sent to the department by South Dakotans, initiated assays for loose smut in seed barley, and initiated detection and control of the Dutch elm disease.

In addition he was on call to advise County Agents, farmers, home gardeners, and other plant propagators on plant disease problems and on regulations concerning the use of chemicals for their control. Wood also conducted biannual surveys for winter wheat diseases and supervised the potato certification program for South Dakota.



Westside of Plant Physiology Laboratories
Annexed to west side of Plant Pathology (1971)



Plant Pathology Complex (1955)
Renamed Plant Science Building in 1972

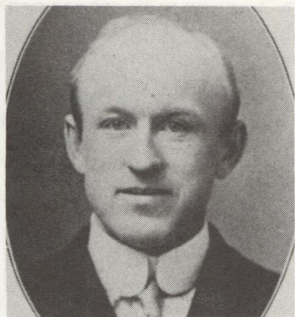
CHAPTER V ENTOMOLOGY-ZOOLOGY

Entomology and Zoology were taught at the Dakota Agricultural College as early as 1887. An Assistant Entomologist was appointed in 1888 and the Entomology-Zoology Department was formed in 1920. The department was dissolved in 1979 and Entomologists were transferred to the Plant Science Department.

DEPARTMENT HEADS

Though the Department of Entomology was a department for more than 80 years, only three men served as Head. They served a total of 63 years.

Harry C. Severin	1916-1953
Dr. Gerald B. Spawn	1954-1963
Dr. Robert J. Walstrom	1963-1979



H. C. Severin-1914



R. J. Walstrom

EXTENSION LEADERS

Extension Entomologists, like Extension Agronomists, were responsible to the Director of Extension. In the late 1960s and 1970s, they reported to the Head of the Department of Entomology-Zoology. On July 1, 1979, they became part of the Plant Science Extension staff.

Anson L. Ford	1920-1934
George I. Gilbertson	1937-1943
John A. Lofgren	1951-1955
William M. Hantsbarger	1958-1961
Gale B. Mast	1961-1962
Dr. Benjamin H. Kantack	1962-
Dr. Wayne L. Berndt	1963-

In 1976 Dr. Edward U. Balsbaugh, Jr., Zoologist in the Entomology-Zoology Department, wrote "History of Entomology-Zoology at SDSU" in commemoration of the national bicentennial celebration. It was updated by Entomologist Burress McDaniel in 1980.

Balsbaugh and McDaniel

Insects were always of concern to residents of South Dakota and in all probability will

remain so far into the future. Insects preceded even pre-historic man and continued to trouble the Indians into historic times and later, the early white settlers.

On May 4, 1877, the Governor of the Dakota Territory declared a territorial day of prayer to deliver the area crops from total disaster caused by continuing grasshopper devastations. Such early recognition of the severity of insect problems in South Dakota led to the inclusion of Entomology classes among the first curricula at Dakota Agricultural College in 1884. The Agricultural course and the General Science Course included Entomology and Zoology as required subjects. The Agricultural course included: Physiology and Anatomy, Zoology, Entomology, Embryology, and Elements of Biology; and the General Science Course listed all of the aforementioned, except Entomology.

ORGANIZATION

The first instructor for both Entomology and Zoology was probably I. H. Orcutt, M.D. Ph.D., who was elected Professor of Natural Sciences in 1885 and Professor of Zoology, Entomology and Physiology in 1887--the first year that classes in either topic were taught.

Investigational work in Entomology financed through Experiment Station funds, began in South Dakota on July 1, 1888. The first Station Entomologist was I. H. Orcutt. John Aldrich was appointed Assistant Entomologist on that date. He was the first full-time Entomologist and the first alumnus to receive a staff appointment. He held the position for 3 years.

Entomology was involved in two of the four major activities of the college--Teaching and Research.

One employee handled more than one discipline most of the time for a third of a century. Over a 5-year period (1887-1892) Zoology, Entomology and Physiology were combined with one staff member for 3 years and a second staff member for 2 years. Entomology and Botany were handled by one person in 1893, 1894 and 1896-1906, but there was one full-time employee for Entomology in 1895 and 1907-1920.

In 1920 Entomology and Zoology were combined into the Entomology-Zoology Department with Harry C. Severin as Department Head. Also in 1920, Anson L. Ford became an Extension Horticulture-Entomology Specialist. Though he was not assigned to either department, Entomology became involved in Extension,

the third of the four major areas of activity at the College.

In 1925 the Department was transferred from the Division of General Science to the Division of Agriculture (Regents' minutes), but the name of the department did not change until July 1, 1979.

Dr. Gerald B. Spawn, a Zoologist, joined the Department in 1938. He introduced five new courses in Wildlife and Wildlife Management the first year. The college catalog for 1939-1940 included a major in Wildlife Techniques (K-86). It proved to be a popular curriculum.

In 1963 Wildlife staff members formed a Wildlife Department with Spawn as Department Head. The Department was later renamed Wildlife and Fisheries Sciences.

Dr. Robert J. Walstrom was appointed Head of Entomology-Zoology in 1963. He served until July 1, 1979, at which time Entomology was placed in the Plant Science Department and Zoology was combined with the Botany-Biology Department to form the new Biology Department.

ENTOMOLOGICAL RESEARCH

Entomological research began in the Agricultural Experiment Station when I. H. Orcutt initiated studies on the potato beetle. In 1886 Orcutt described the damage of this pest and recommended controlling it with Paris green insecticide. In 1888 and 1889, respectively, he published a bulletin on the need of entomological investigations in South Dakota and a general publication on entomological pests in the state, in which he cautioned that patented insecticides were generally too expensive to use.

From 1905 to 1925, the office of the State Entomologist for South Dakota was filled by the Experiment Station Entomologist. His official duties were to inspect the nurseries of South Dakota, issue certificates of inspection, and collect fees.

In 1909 H. C. Severin was named Professor of Entomology and Nature Study. Now the study of nature was condoned, at least in title. He became Experiment Station Entomologist in 1916. However, entomological investigations were primarily "mission-oriented". Early experiment station publications (i.e. from 1888-1930) dealt mainly with garden pests, pests of trees, flies, grasshoppers, and pests of cattle. The making of a permanent insect collection also began at this time and, this too, assumed pragmatic significance as it developed in size and arrangement.

In 1931, James W. Wilson, long-time (1902-1937) Director of the Agricultural Experiment Station wrote, "Although Entomology figured from the first on the station records, it hardly had an independent existence for many years as the early Entomologists were either interested in other matters or had little time to give to the subject. Robert Matheson, in charge of Entomology from 1907 to 1909, was a scholarly bugman but he wrote no bulletins.

With the appointment of H. C. Severin in 1916 things became different. He had the interest and found the time to do excellent work. With his assistant George I. Gilbertson, he wrote a number of valuable bulletins. The value of Professor Severin's work was greatly increased by the opportunities as State Entomologist, which position he has had from 1909" (W-89).

Grasshoppers

During the 1930s, both Entomology research and Extension work involved grasshopper control investigations. Control studies and surveys were conducted. The public benefited from recommendations of efficient use of baits for control of these pests, as well as from the surveys which were useful for predicting outbreaks. As a consequence of these surveys, the department insect collection greatly enlarged. For example, in 1936 over 10,000 specimens of various grasshoppers and their relatives were added to the collection.

Livestock Insects

Programs during the 1940s included recommendations for controlling pests of Victory Gardens during the war years and then in the latter half of the decade, advisement to the livestock growers on means of controlling screwworms.

In the late 1940s and early 1950s, research and Cooperative Extension work was conducted with the Livestock Sanitary Board in the area of Highmore. These programs amply demonstrated that livestock pests, such as screwworms, cattle grubs, stable flies, mosquitoes, lice and mites could be controlled by cooperative efforts.

In the early 1960s the face fly became a pest to livestock in South Dakota. The insect fed on mucous secretions around the eyes and muzzle of livestock. Not only did it prevent normal feeding--and hence reduction in weight gains--but it also was responsible for transmission of organisms causing pink-eye, a major source of blindness in cattle.

Work began in South Dakota with aerial application of insecticides for control of face flies, as well as horn flies--probably

the first aerial applications for rangeland cattle. Because it was the first time this technique had been used, requests for information were received from the major cattle raising areas of the world.

Mosquitoes

A survey of the mosquitoes of South Dakota also was conducted during the 1960s and control techniques were developed for suppressing their larvae. Not only were these controls adopted by many municipalities and counties for the benefit of public health, but the survey was a boon to current research by the Microbiology Department's investigations of encephalitis which is transmitted by mosquitoes.

Alfalfa Insects

Investigations of insects associated with alfalfa commenced in the 1960s. These included two separate aspects. One investigation included the use of insect pollinators to increase seed set. Honey bees were compared with newly introduced leaf-cutter bees, which proved to be highly efficient as pollinators.

The alfalfa weevil entered South Dakota from the west and from the southeast. Control measures were studied, including various chemical and physical means, as well as introductions of parasitic enemies. In 1973 a tiny parasitic wasp (*Bathyplectes annurus*) which attacked the alfalfa weevil was recovered in South Dakota. This species had been released in 1971 in hopes that it would become established and serve as a biological damper on the alfalfa pests.

Corn Insects

Some of the first attempts at biological control of insect pests were made. Newly introduced problems to corn, the European corn borers, were attacked by intentional introductions of *Lydella* flies and *Homogenes* wasps, released in an attempt to reestablish an already disrupted ecosystem.

Research on corn insects during the 1960s and continuing into the decade of the 1970s involved the three species of corn rootworms. Various chemicals were tested so that efficient controls could be recommended. Of significance in these studies was the demonstration, in 1964, that corn rootworms had developed genetic resistance to certain insecticides.

Rangeland Insects

The surprising discovery, in the early 1970's, that mites and scale insects extract

amazing amounts of nutrients from rangeland grasses that could otherwise have gone into the production of beef was of great significance. This discovery resulted from combined work on rangeland insects through the Experiment Station and a cooperative investigation of the International Biological Program, involving several universities of the Great Plains.

Greenbugs

Pests of small grains, specifically wheat and sorghum, in the early 1970s included the greenbug, a plant louse which annually was blown in from the South. The evolution of new strains of greenbugs, including resistant forms, dictated that control methods include parasite introductions, as well as integrating these with systemic chemicals.

Weeds

New techniques for controlling weeds with insects were also attempted in the 1970s. Several species of insects, which fed only on a given weed, were brought into the state in attempts to establish them here. Such methods could lead to cheap control means without adversely affecting the environment.

THE INSECT COLLECTION

The establishment of a museum was an early priority with the founders of the college. The Second Annual Catalog (1886-1887) included the first report on the museum, which was housed in "...one of the largest, most commodious and beautiful rooms of the Territory." The museum contained minerals, shells, fossils, and zoological specimens, and plans had been laid to enlarge the collections as rapidly as possible in other areas, including Entomology. I. H. Orcutt, was the first Curator.

In 1888 John M. Aldrich joined the staff of the Department of Entomology. More than likely, Aldrich contributed enthusiastically to the Insect Collection during his employment at Dakota Agricultural College for he later attained considerable renown as a specialist of flies.

In 1892 Entomology was associated with Botany and the Entomology collection was separated from the Museum, which had been situated on the third floor of the Main Building (Central). The Insect Collection was transferred to the second floor of the old dormitory building (South) and was curated by Professor Thomas Albert Williams in the Botanical and Entomological Laboratories.

The Tenth Annual Catalogue and Calendar of the South Dakota Agricultural College for 1893-1894 reported that "...the insect collection is

a representative one, and is particularly rich in beneficial and noxious species found in the state"

De Alton Saunders was named in 1896 to replace Williams. Saunders served through 1903. From 1903 to 1906, the Insect Collection was in the charge of William Archie Wheeler, Professor of Botany and Entomology. In 1906 Robert Matheson was named Instructor in Entomology, taking over from Wheeler.

Separation of the insect specimens from the Museum proper in 1892 proved to have been of little lasting benefit for the permanence of either collection. The Museum's collection of mammals and birds became neglected and severely deteriorated, especially after having been moved to South (now the Old Extension Building). The fumes from a soils laboratory ruined most of the birds and mammals.

The insect collection fared little better. When Severin came to South Dakota State College in 1909, he reported that there was no collection of insects in the college worthy of the name. The few hundred specimens that were in the department were "moth" eaten and in such a state that it was necessary to destroy them.

Chiefly through Severin's efforts, the Insect Collection grew by leaps and bounds. It was housed in the Horticulture Building until 1935 when it was transferred to the "Entomology Annex" of the Extension Building, a structure presently (1975) used for music practice.

The Truman Collection of Philetus C. Truman was purchased for \$2,000 in 1911. This collection consisting of *Lepidoptera* and *Coleoptera* entirely, contained specimens principally from the United States, Canada, Mexico, South and Central America, and the British Isles. The exotics were chiefly *Lepidoptera* and *Coleoptera* from Great Britain.

This collection was incorporated into the general collection. A native of New York, Truman homesteaded in Lake Sinai Township, Brookings County, in 1881. Labeling errors have been detected among some of Truman's specimens and some caution is urged in treating the Truman material.

In 1930 the first report on the status of the SDSC Insect Collection was made to the Entomological Society of America which indicated strength in the holdings of *Orthoptera*. Already the collection was valued at \$40,000 and was well on the way to becoming one of the major collections of insects in North America. A second report to the Society indicated that during 1933 considerable progress was made in identification of *Coleoptera*. Many *Meloidae*

were collected during the year as a part of the work on an Experiment Station project.

In 1937, Severin made the final report on the status of the Insect Collection to the ESA. Ten thousand specimens, other than *Orthoptera*, were added to the Collection during the previous year and special surveys of the *Meloidae* had continued.

In 1953 the SDSU Insect Collection was moved to room 308 of Agricultural Hall whose every nook and cranny was filled. In 1956 Severin estimated that the collection surpassed the 1 million mark for total number of specimens.

The collection was later ranked by the Entomological Society of America among the largest 25 in North America.

Edward U. Balsbaugh, Jr., joined the staff in 1965 and became active curator. Under his direction, major rearrangement of the collection was achieved and new metal cabinets were acquired. The collection continued to grow, but in restricted areas. Balsbaugh's major interests were the *Coleoptera*, especially the *Chrysomelidae*.

In 1976 the policy of the Entomology-Zoology Department was to keep any type material it acquired. In making this decision, the dangers of heavy centralization of types in larger museums were weighed against a possible more lax curation at smaller institutions. Continuing adequate protection for type specimens could be provided at SDSU.

The Insect Collection was particularly strong in its holdings for South Dakota, but it also contained long series in certain groups from specific areas--for example, many *Homoptera* from Alaska which Severin had collected.

The Truman Collection, of course, gave breadth to the collection of *Lepidoptera* and practically all faunal realms were represented in the family *Papilionidae*. The collection also contained *Orthoptera* from all over the world. Severin also collected in many other western states, and good series in certain groups were available from Colorado, Montana, Wyoming, as well as from Minnesota.

Orders particularly well represented in the SDSU Insect Collection included *Coleoptera*, *Orthoptera*, *Hemiptera*, *Homoptera*, *Diptera*, *Hymenoptera*, *Lepidoptera* (especially exotic butterflies and endemic moths) and some *Neuroptera*, *Odonata*, *Mallaphaga*, and *Dermoptera*. More poorly represented were the *Trichoptera*, *Plecoptera*, *Ephemeroptera*, *Siphonaptera*, *Thysanoptera*, *Anaplura* and *Mecoptera*. The collection also contained a

small assemblage of immatures which were chiefly used for teaching purposes.

After Burress McDaniel joined the staff in 1966, the slide collection of *Acarina* was enlarged. Its areas of strength included the *Prostigmata* and *Astigmata*. Because of his interest in the collection, he became curator when Balsbaugh left SDSU in 1976.

STAFF MEMBERS

There were three staff members in the Entomology-Zoology Department when it was formed

in 1920. The teaching and research staff had increased to four in 1940 and five in 1953 when Severin retired and Spawn became Department Head.

In 1963 there were eight staff members when the department was divided to form the new Wildlife Department. After the division Entomology-Zoology had a teaching and research staff of six. This increased to ten in 1969 and dropped to nine in 1979. Four Entomologists were transferred to the Plant Science Department on July 1, 1979.

In a period of 95 years almost 50 persons served as Entomologists (E) and/or were members of the Entomology-Zoology Department. The list includes Entomologists who also served as Botanists (B) or Zoologists (Z). It also includes Zoologists or Wildlife specialists (W) who were members of the Entomology-Zoology Department.

I. M. Orcutt (EZ)	1885-1892	M. U. Allum (Z)	1956-1963
J. M. Aldrich (E)	1888-1891	W. T. McElroy (E)	1956-1957
T. A. Williams (BE)	1891-1896	D. R. Progulsk (W)	1956-1963
D. A. Saunders (BE)	1896-1903	R. L. Linder (W)	1960-1962
W. A. Wheeler (BE)	1904-1907	J. F. Wagner	1960-1961
R. Matheson (E)	1907-1909	A. E. Dracy	1961-1962
H. C. Severin (E)	1909-1964	G. B. Mast (E)	1961-1962
M. Fowlds (E)	1913-1914	V. A. Hall (Z)	1962-1965
G. I. Gilbertson (E)	1914-1945	B. H. Kantack (E)	1962-1963
N. A. Hartwig	1927-1977	R. W. Gerhardt (E)	1963-1966
W. R. Horsfall (E)	1937-1938	A. Greichus (Z)	1963-1979
N. P. Larson (E)	1938-1942	M. Harsch (Z)	1964-1965
G. B. Spawn (Z)	1938-1943	S. P. Trautman (Z)	1964-
	1946-1963	L. D. White (E)	1964-1965
R. J. Greb (Z)	1946-1969	E. U. Balsbaugh, Jr. (E)	1965-1976
J. A. Lofgren (E)	1947-1951	P. Haman (Z)	1965-1966
W. M. Rogoff (E)	1947-1962	P. A. Jones (E)	1965-1974
W. L. Berndt (E)	1950-1954	G. A. Thibodeau (Z)	1965-1978
J. H. Camin	1950-1952	B. McDaniel (E)	1966-
P. H. Kohler	1950-1951	M. H. Roller (Z)	1966-
E. J. Huggins (Z)	1952-	J. D. Haertel (Z)	1969-
T. B. Thorson (Z)	1954-1956	G. R. Cizaldo (Z)	1972-
W. M. Hansbarger (E)	1955-1961	D. D. Walgenbach (E)	1974-
R. J. Walstrom (E)	1955-	D. J. Call (E)	1974-1975
W. C. Mitchell (E)	1955-1956	E. R. Easton (E)	1976-

CHAPTER VI PLANT SCIENCE DEPARTMENT 1969-1979

The Department of Plant Science was formed July 1, 1969, by Dr. D. C. Acker, Dean of Agriculture and Biological Sciences. He had previously merged the Poultry Department, when the Department Head retired, with the Animal Husbandry Department to form the Animal Science Department and had discussed the possibility of also including the Department of Dairy Science in the new Department.

INTERSPECIFIC CROSS 1969-1979

In the spring of 1969, L. O. Fine announced his intentions of resigning as Agronomy Department Head on June 30. C. M. Nagel, Head of Plant Pathology, was scheduled to retire on the same date.

The Dean called a meeting of staff members from Agronomy and Plant Pathology to discuss the possibility of merging the two departments. During the discussion, he mentioned the possibility of eventually adding Horticulture-Forestry and Botany-Biology to form a Department of Plant Science. He asked for suggested names for a department that would include Agronomy and Plant Pathology. There was little sentiment among staff members from either department for such a merger. The Agronomy Department was already the largest department on campus. Most Agronomists did not want to be party to a merger in which a large department "gobbled up" a much smaller one. They felt that such a merger could strain the good working relations among staff members in the two departments. Pathologists were opposed to the merger because they were afraid they would lose their identity.

Most staff members agreed that if the two departments were combined, the name should reflect the major elements of the department--

crops, soils, weeds and plant pathology. Such names as Agronomy and Plant Pathology, Plant and Soils Sciences, and Soils and Plant Sciences were suggested.

Though there was little enthusiasm for joining the two departments and no interest in the name "Plant Science", the Dean decided that the Agronomy and Plant Pathology would be combined into a Plant Science Department.

Department Heads

To date three men have served as Department Head:

Dr. Raymond A. Moore	7/1/1969-6/30/1973
Dr. Charles R. Krueger	7/1/1973-6/30/1978
Dr. Frederick C. Westin*	7/1/1978-10/31/1978
Dr. Maurice L. Horton	11/1/1978-

*Acting Department Head in 1978 and from October 9 to December 9 in 1980.

Research and Teaching Staff

The 24 professional members in Agronomy and five Plant Pathologists totalled 29 teaching and research staff members in the newly formed department. The three Assistants in Agronomy and one Assistant in Pathology, who were junior scientists that worked full-time in the department while earning M.S. degrees, brought the total to 33--the number of staff members that had been in the Agronomy Department in 1959. The new department was the same size as the Agronomy Department had been because the addition of Plant Pathologists offset the decrease in Agronomists during the decade.

Ten years later, there were 18 Agronomists, five Pathologists and ten Assistants in Plant Science for a total of 43.

Members of the research and teaching staff with the rank of Instructor or above, who were in the department during the entire 10-year period, included Fine, Shank, Westin, Ross, Carson, Erion, Shubeck, Mankin, White, Kingsley, Price, Geise, Buchenau, Kenefick, Dybing, Evenson, Wells, Bonnemann, Lunden, Smolik, Gardner, and Otta. Members who either left the department or joined it during the period are listed below:

Dr. Clatus M. Nagle	1/1/44-6/30/75	Pathology
Raymond C. Kinch	2/1947-6/30/76	Seed Test Lab
Dr. George Seminuk	1952-6/30/75	Pathology
Dr. Raymond A. Moore	1956-6/30/73	Teach. Pasture and Head
J. Duane Colburn	1957-1978	Seed Certification
Dr. Dwight R. Hovland	1960-1970	Soil fertility
Dr. Melvin D. Rumbaugh	1960-1977	Alfalfa breeding
Dr. Raymond C. Ward	8/1/62-6/30/72	Soil Testing Lab
Dr. Rulon Albrechtsen	1962-1969	
Dr. Jimmy Stritzke	1965-1969	

Dr. Charles Frazee	1969-1974	Asst Soil survey
James B. Weber	1969-	FSSD
Dr. Charles R. Krueger	3/1/70-6/30/78	Pasture and Head
Dr. Dale L. Reeves	1970-	Oat breeding
Dr. W. Eugene Arnold	3/1/70-	Weeds
Dr. Robert Pylman	1972-1976	S. Wheat breeding
Bernard Byrnes	1972-1974	Soil Testing Lab
Dr. James E. Green	1974-1976	Pasture
Dr. Ron H. Gelderman	1974-	Soil Testing Lab
Dr. Robert A. Kohl	3/1/75-	Asst Soil physics
Dr. Douglas D. Malo	3/15/1975-	Asst Soil survey
Dr. Charles L. Lay	1975-2/27/81	Flax breeding
Dr. Donald L. Keim	1977-	S. Wheat breeding
Dr. F. Rudolph Vigil	4/1/77-	Pasture
Robert J. Pollmann	7/10/78-	Seed Certification
Dr. Maurice L. Horton	11/1/1979-	Dept. Head
Dr. Arvid A. Boe	12/17/1979-	

James B. Weber was employed as assistant manager of the Foundation Seed Stock Division in 1969, and Charles Frazee filled the vacancy left when G. J. Buntley resigned. R. A. Moore became Department Head, leaving a vacancy in the pasture program. C. R. Krueger was appointed to that position in 1970.

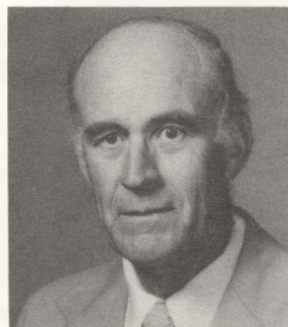
Pathologists who became members of the Plant Science Department in 1969 included Clatus M. Nagle, George Semeniuk, Cleon J. Mankin, George W. Buchaneau, James D. Smolik, Wayne S. Gardner and Jack Otta.



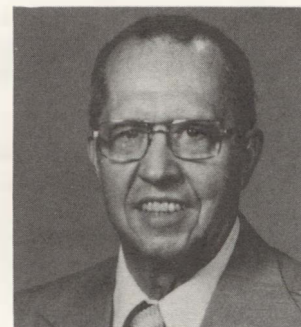
C. Frazee



C. R. Krueger



C. J. Mankin



W. S. Gardner



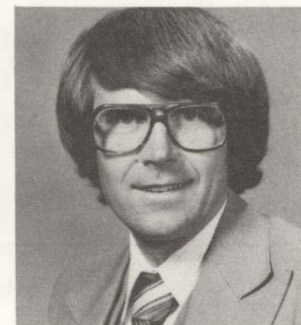
C. M. Nagel



G. Semeniuk

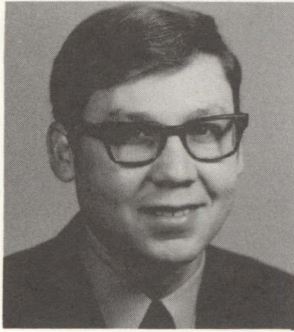


J. D. Smolik

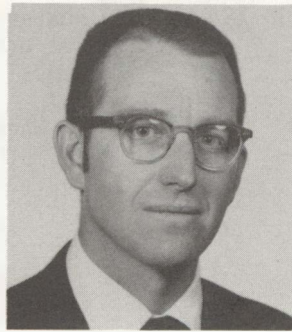


J. D. Otta

Oat breeder Albrechtsen and weed researcher Stritzke resigned in 1969. They were replaced in 1970 by W. Eugene Arnold and Dale L. Reeves, respectively. Also in 1970 D. R. Hovland resigned from the soils staff.



W. E. Arnold



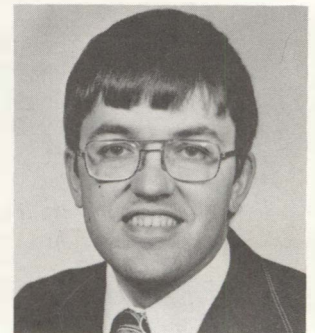
D. L. Reeves

A spring wheat breeder was added to the staff in 1972 in the name of Robert Pylman, Jr. R. C. Ward left the Soil Testing Laboratory to become the manager of the James Valley Research and Extension Center at Redfield. He was replaced by Bernard Byrnes. M. L. Horton transferred to the Water Resources Institute in March 1973. C. R.

Krueger succeeded Moore as Department Head in 1974, and was replaced by James E. Greene. Byrnes resigned and was succeeded by Ron H. Gelderman. Robert A. Kohl replaced Horton as soil physicist in 1975. Frazee resigned in 1974 and Douglas D. Malo became assistant in soil survey in March of the next year.



R. A. Kohl



D. D. Malo

Extension Specialists

An Extension Plant Pathologist was added to the group of crops, soils and weed specialists on July 1, 1969. Three years later, for the first time, the Department Head included Extension Specialists in the Department budget and recommended the salary that each should receive. The specialists are listed below:

Elmer E. Sanderson	7/1/1945-6/30/1973	Crop production
Ralph A. Cline	11/1/1949-6/30/1972	Crop production
Dr. Lyle A. Derscheid	3/1/1960-7/15/1979	Agronomist
Earl P. Adams	2/16/1963-6/22/1978	Soil fertility
Edward J. Williamson	7/1/1967-4/30/1979	Soil conservation
Dr. Leon S. Wood	4/4/1962-	Plant Pathology
Leon J. Wrage	10/1/1969-	Weeds
Dr. Robert Hoeft (80%)*	7/1/1972-11/16/1973	Crop production
J. Duane Colburn (70%)	7/1/1973-6/30/1975	Crop production
Dr. Robert Pylman (30%)	7/1/1973-6/30/1975	Crop production
Dr. James R. Johnson(80%)*	5/1/1974-7/1/1977	Crop, Range
Dr. Donald J. Reid	8/1/1975-	Crop production
Claire E. Stymiest(80%)*	7/5/1978-	Crops and Weeds
Paul D. Weeldreyer	8/15/1978-	Soils-irrigation
Robert P. Schoper	1/15/1979-	Soil fertility

* Located at Rapid City.

Activities

During 1969 the South Dakota Wheat commission voted to provide \$100,000 to supplement a state appropriation to build a research facility for spring wheat breeding.

The South Dakota Crop Improvement Association, with support from the South Dakota Seed Trade Association, lobbied the Legislature for

the appropriation. The 1970 Legislature appropriated \$200,000 for the building and The Foundation Seed Stocks Division provided \$40,000 for equipment. The physiology laboratory-greenhouse complex was annexed to the Plant Pathology Building. It was dedicated on Agronomy Field Day July 8, 1971.

Because of lack of operating funds, the possibility of closing the substation at

Eureka and Highmore and the Mobile Research Farms at Watertown, Garden City, Twin Brooks and Presho was considered.

After several staff conferences and farmer meetings in the areas, the Eureka substation was closed June 30, 1971. The South Central Research Farm was closed in 1973 and the equipment was transferred to the West River Research and Extension Center at Rapid City where a field headquarters was established. However, all research from Rapid City was done on land of private cooperators.

The West Prairie Coteau Research Farm at Garden City and the Whetstone Valley Research Farm near Twin Brooks had been in operation for 8 and 5 years, respectively, and were closed as scheduled in 1973.

In 1972 the station at Highmore was renamed Central Crops and Soils Research Station and more emphasis was put on research at that location. In addition to the research done in the station, it too was used as a base for conducting research on the farms of private cooperators.

The South Dakota Crop Improvement Association asked the Legislature for a special appropriation of \$100,000 to inaugurate a spring wheat breeding program. The 1972 Legislature appropriated \$70,000 for that purpose. Robert Pylman was employed as a spring wheat breeder and Mrs. Kathy Sellers as a technician.

The South Dakota Wheat Commission and the Foundation Seed Stock Division allocated funds for the purchase of equipment needed for the project.

Race 371 of flax rust was identified in the Dakotas and Canada in 1973. Most flax varieties were susceptible to it. Linnott was the only high yielding variety adapted to South Dakota that was tolerant to the fungus.

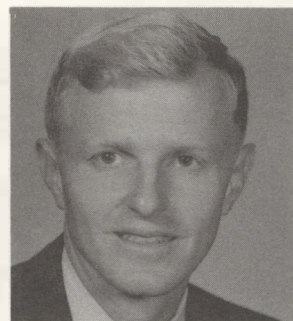
In 1974 members of the Crop Improvement Association suggested that \$50,000 be provided to expand the flax breeding project in the Plant Science Department. The 1974 Legislature made a special appropriation of \$50,000 and established a flax check-off. One-tenth of a cent from each bushel of flax sold was allocated by the state to pay for the program. It so happened that flax production dropped and the check-off did not provide \$50,000, but annual appropriations in that amount were made annually for several years. Dr. C. L. Lay was added to the staff as a flax breeder in 1974.

Dr. F. C. Westin was selected by agricultural students in 1975 as "Teacher of the

Year" in the College of Agriculture and Biological Sciences. Four years later he was awarded the Teaching Award of Excellence by Gamma Sigma Delta.

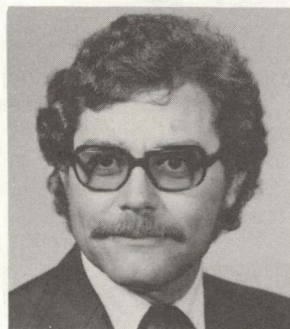


R. W. Pylman



C. L. Lay

Pylman and Green resigned in 1976. During the next year Donald L. Keim became the spring wheat breeder and F. Rudolph Vigil assumed teaching responsibilities for forage crops and research responsibilities for pastures.



D. L. Keim



F. R. Vigil

New Varieties

Two new oats varieties, that had been developed by R. Albrechtsen and D. L. Reeves, were released. About 3,000 bushels of Chief were distributed to Registered seed growers in 1972 and about 11,000 of Spear in 1975. An attempt was made to select an Indian name for Spear. Arrow was suggested because the stems were strong and "straight as an arrow." However, the name had been patented for some other crop and Spear was used instead.

In 1976 when the nation was celebrating the "Bicentennial," people from Eureka asked that a new wheat variety be named for their town which had been the world's largest wheat shipping center for several years in the 1890s. In 1977, the first spring wheat variety from the new program was named Eureka; 1,550 bushels of Foundation seed were released to registered seed growers.

During this 10-year period ten inbred lines of corn, developed by D. B. Shank, and 21 inbreds developed by C. M. Nagel were released to commercial corn breeders and other geneticists for use in development of new corn hybrids.

From 1971 to 1974 sorghum grain varieties SD 104 and SD 106 and the grain sorghum hybrid SD 506, developed by A. O. Lunden, were released to growers. Also SD 106ms, a male-sterile line was released to sorghum breeders for use in developing new sorghum hybrids.

In 1975 the Plant Science Department cooperated with the Agronomy Departments of North Dakota and Minnesota and the USDA in the release of Culbert, a variety of flax that was resistant to Race 371 of flax rust. Culbert 79, a flax variety developed by C. L. Lay, was released to South Dakota growers in 1979.

Rebound, a smooth brome grass variety developed by J. G. Ross was released in 1979. Oahe intermediate wheatgrass, Summer switchgrass, Teton and Travois alfalfa had been released under the system used for small grains, flax and soybeans. However, these varieties were all but lost in less than 20 years.

Therefore, Rebound was released to a group of three commercial seed companies, who agreed to produce, and market certified seed for as long as there is a demand for the variety and to pay a royalty to the Experiment Station for each pound of seed marketed.

Cottonwood smooth brome grass and Retain creeping foxtail, also developed by Ross, were released in 1980 as was James spring wheat developed by D. L. Keim.

INTERGENERIC CROSS 1979

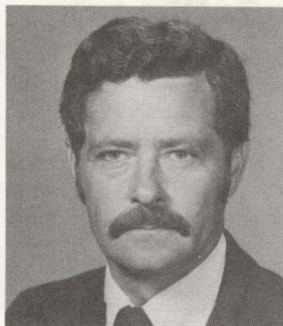
In 1979 a federal program of Integrated Pest Management (IPM) was inaugurated for both the Experiment Station and Extension Service. It advocated the use of integrated cultural and chemical practices for pest management--weed, insect and disease control. Though such a program had been in effect for a quarter of a century in South Dakota, Dr. Delwyn D. Dearborn, the Dean of Agriculture and Biological Sciences, was intrigued by the concept. Some Entomologists seized upon the opportunity to suggest a new IPM Department. In a departmental staff meeting, they voted to leave the old Entomology-Zoology Department for a new one. Several Pathologists were disenchanted with their position in the Plant Science Department and were sympathetic to the idea. The weed people were opposed to the idea and some Pathologists reversed their position.

The following article appeared in the Brookings Register in July 1979: "Delwyn Dearborn, Dean of Agriculture, said the Entomology-Zoology Department has been split. Entomology has been combined with Plant Science Department under that name and Zoology has been placed under Botany-Biology. Two animal physiology staff members have been transferred to the Vet Science Department to provide additional research capabilities there.

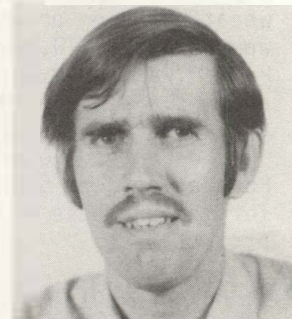
"The pest management curriculum', Dearborn said, 'has gained additional federal emphasis.' SDSU's crop pest management curriculum was added last year but Dearborn hopes for additional emphasis this year with all facets under one department."

Dr. Maurice L. Horton, who had been named Head of the Plant Science Department November 1, 1978, remained as Head of the enlarged Department.

Four Entomologists were transferred to the Plant Science staff--Robert J. Walstrom, Burress McDaniel, David D. Walgenbach and Emmett R. Easton.



D. D. Walgenbach



E. R. Easton

Plant Science Staff Members

The research and teaching staff included 28 Agronomists, five Pathologists, and four Entomologists for a total of 37 senior scientists on July 1, 1979. The nine Assistants in Agronomy and one in Plant Pathology brought the total number of senior and junior staff members to 47.

The number of Extension Specialists increased from six in 1969 to ten in 1979. A Pathologist was added in July of 1969, another Agronomist in August of 1978 and two Entomologists in July 1979.

During the 2 years after July 1, 1979 several staff changes took place. Lyle A. Derscheid retired on July 15, 1979. Boyd Shank retired June 30, 1980 and was succeeded by Zeno W. Wicks, III on September 1.

Staff members with professorial rank in the Plant Science Department on July 1, 1979, were as follows:

Crop Breeding

A. A. Boe
D. L. Keim
C. L. Lay
P. B. Price (USDA)
D. L. Reeves
J. G. Ross
D. B. Shank
D. G. Wells

Soils

P. L. Carson
P. D. Evenson
L. O. Fine
R. H. Gelderman
R. A. Kohl
D. D. Malo
F. C. Westin
E. M. White

Extension Specialists

L. A. Derscheid
W. L. Berndt
B. H. Kantack
D. J. Reid (Crop)
R. P. Schoper
C. E. Stymiest
P. D. Weeldreyer
L. J. Wrage
L. S. Wood

Seeds

A. O. Lunden
R. J. Pollmann
J. B. Weber

Research Stations

H. A. Geise
Q. S. Kingsley
F. E. Shubeck

Pathology

G. W. Buchaneau
W. S. Gardner
C. J. Mankin
J. D. Otta
J. D. Smolik

Crop Performance

J. J. Bonnemann
G. W. Erion

Crop Physiology

C. D. Dybing (USDA)
D. G. Kenefick

Entomology

E. R. Easton
B. McDaniel
D. D. Walgenbach
R. J. Walstrom

Pasture

F. R. Vigil

Weeds

W. E. Arnold

James G. Ross retired on June 30 1981. He and Derscheid will be replaced by a forage crop specialist who will work 60% for Extension and 40% for research. Frederick C. Westin transferred to Remote Sensing on May 11, 1981 and was succeeded by Gary A. Lemme on August 1 of the same year.

Jack D. Otta resigned in 1979 and was succeeded by Martin L. Carson in August 1980. Michael W. Ferguson was employed April 1, 1981 to replace Cleone J. Mankin who retired June 30, 1981. Donald L. Keim resigned July 15, 1981.



Foundation Seed Stocks Building (1955)

CHAPTER VII PROFILES OF PEOPLE

The writer approaches this topic knowing full well that he will omit someone who should be included. However, short biographies are included for several individuals who were instrumental in the establishment of Agronomy at SDSU and/or were staff members for a short time before moving to higher positions. Longer biographies are included for a number of long-time staff members who made major contributions to the Department, the University and the State. Only one is still an active member. He has been honored as a Fellow in the American Society of Soil Science.

PIONEERS IN AGRONOMY

John M. Aldrich enrolled as a student in the Dakota Agricultural College in 1885. He was one of three in the class of 1888, the first class to graduate.

In 1888 he took notes on the 66 plots of grasses and grains that had been planted at the newly established Agricultural Experiment Station. He served as Assistant Entomologist from 1888 to 1891 and received an M.S. degree in 1891. His was the first advanced degree conferred by the young institution and he was probably the first alumnus to receive a staff appointment.

He left the Experiment Station in 1891 and became an expert on flies, but apparently did not forget his alma mater. In 1930 he wrote a letter for "the history" that was edited by Wm. H. Powers. Aldrich described the institution as he first saw it and discussed life at the college when he was a student.

Thomas Albert Williams was the first Botanist at the Experiment Station. His courses included information about Agronomy, Plant Pathology and Entomology as well as Botany. He was intensely interested in forage crops and planted numerous plots at Brookings. He probably planted the plots on the Hunter Farm near Mellette in 1895 and 1896.

Williams resigned in 1896 to join the Agrostology Division of the USDA. During 1898 he made a collecting trip through Western South Dakota, Wyoming and Montana to obtain seeds and plants native to those areas. During the next winter he was the USDA representative that developed the Cooperative Agreement between the Division of Agrostology and the South Dakota Agricultural Experiment Station to establish the Cooperative Range Field Station at Highmore in 1899. Many of the species that he had collected were planted at Highmore by his successor, De Alton Saunders.

E. C. Chilcott may have been a South Dakota resident before he was appointed Agriculturist in February 1893. He was superseded by E. A. Burnett during 1895, but returned a year later. He served as Agriculturist and Vice Director of the Experiment Station until he resigned June 30, 1905.

Chilcott established the first crop rotation experiment on West Farm in 1897 and summarized the results 5 years later. During the winter of 1898-1899, he traveled to Washington, D.C., to propose the establishment of a Cooperative Experiment Station at Highmore. He supervised the establishment of the station in 1899.

Two years later the Experiment Station entered into an agreement with the Bureau of Plant Industry of the USDA to cooperate in grain investigations to be conducted at Brookings and one other location. Chilcott supervised the program which included tests on the Hunter Farm near Mellette in 1901 and 1902, and at Highmore from 1903 to 1905. He assisted with the establishment of crop rotation experiments initiated at Highmore during 1904 and 1905.

Chilcott joined the Bureau of Plant Industry in July 1905 and assisted with the establishment of dryland crop rotations on the new Belle Fourche Field Station in 1908.

W. A. Wheeler, Botanist, succeeded De Alton Saunders. He had charge of the forage crop work at Brookings and Highmore from 1904 to 1907. He inaugurated plant breeding programs for foxtail millet at Highmore in 1904, and proso millet, alfalfa, corn, sorghum and several grasses in 1905. Also in 1905 he discovered a field of hardy alfalfa near Baltic. It was later named for the town.

Wheeler resigned in 1907 to become Manager of Dakota Improved Seed Co. in Mitchell. He remained with that company until 1916. In that capacity, he actively cooperated with scientists in many states and supplied them with seeds of his alfalfa selections.

Clifford Willis was named Chief in Agronomy and Supervisor of Substations in 1908. During his first year he revised the plot numbering system devised by Saunders and modified the crop rotation experiments initiated by Wheeler or Chilcott at Highmore. He also supervised the establishment of the Eureka and Cottonwood Substations in 1908 and 1909, respectively.

During Willis' tenure, several Agronomists were employed. One Assistant Agronomist was located at Brookings in 1908, two in 1909 and three in 1910. In addition, an Assistant

Agronomist was located at each of the three substations in 1910.

Willis served as Secretary to the South Dakota Corn Growers and Grain Growers. He left the state in November 1911 to become Editor of the *Northwest Farmstead*.

JOHN S. COLE



John S. Cole was born in New York on November 19, 1878. He came to Dakota Territory with his parents in 1886 and entered South Dakota Agricultural College in 1899. He was a senior in the spring of 1901 when he was appointed "Special Agent" with the USDA. At first he assisted

Chilcott with small grain variety tests, but he had charge of cereal breeding for the Experiment Station in 1902. He graduated on June 17, 1903, was named Assistant in Agronomy in 1906 and Assistant Agronomist in 1908.

During the blackstem rust epidemic in 1904 and 1905, he observed the outstanding resistance to stem rust of Iumillo durum wheat and of Yaroslav emmer, which marked the beginning of the first successful attempts to breed rust resistant varieties.

Rust damage to common spring wheat and durum wheats from Spain, Italy and Bulgaria was very severe. However, No. 1736, a durum wheat from Italy, was almost perfectly resistant to the disease.

No. 1736 was later named Iumillo. Because of its rust-resisting genes it was used by the Minnesota Agricultural Experiment Station in developing Thatcher, a hard red spring wheat, which made an important contribution to wheat growing in the Northern Great Plains.

Cole also discovered that four varieties of emmer were highly resistant to rust and yielded about 40 bushels per acre, whereas the yield of other varieties which rusted severely, went as low as 4 bushels per acre.

Among the four resistant varieties of emmer was Yaroslav, which Edgar McFadden later crossed with Marquis to produce Hope and H-44. These McFadden crosses were later used in many wheat breeding programs.

Cole made several crosses with other varieties but these came to naught because of changes in personnel in the Agronomy Department.

Cole and A. N. Hume of Illinois conducted a 3-hour corn school at the first meeting of the South Dakota Corn Growers and Breeders Association (forerunner of South Dakota Crop Improvement Association) on September 28, 1906.

The next year Cole discussed work of the Experiment Stations. Records were not located to verify that he developed the first crop variety released in South Dakota, which was Cole oats, named in his honor in 1909.

Cole left South Dakota in 1908 and went to the USDA office of Dryland Agriculture which had experiment stations in the Great Plains states from Texas to Montana.

Cole retired in 1947. Mrs. Cole died in 1956, and John Cole died on April 6, 1971 at the age of 92.

Stem rust, once the principal scourge, and a bad one, for wheat growing in the Northern Great Plains of the United States and Canada, has been brought under control. It is one of the real important plant breeding achievements of the century, but could not have been done without John Cole's contribution.

SAMUEL CECIL SALMON

Salmon was born July 25, 1885 in a sod house 4 miles south of Emery, Dakota Territory. He attended country schools, and either walked or rode a bicycle 7 miles to Spencer, South Dakota to high school.

He entered South Dakota Agricultural College in the fall of 1902 and graduated June 13, 1907 with a B.S. in agronomy. He worked as a student assistant during his junior and senior years in the Agronomy Department.

For 5 years following his graduation, Salmon was a "Special Agent" of the Bureau of Plant Industry, USDA, in charge of cereal breeding at the Belle Fourche Field Station near Newell, South Dakota.

After serving 17 years as professor of farm crops at Kansas State University he went back to the USDA in 1930 as wheat project leader in the Bureau of Plant Industry.

Twice Salmon was assigned consultant to the U.S. Army in Japan. On his first trip from December 1945 to July 1946, he observed wheat culture in Japan and brought back a number of semi-dwarf wheats. One was Norin-10, a very

short, stiff-strawed variety which attracted his attention because of its resistance to lodging and its apparently high productive capacity.

Dr. O. A. Vogel of the USDA located at Washington State University crossed Norin-10 with Brevor, a local variety, in 1949. As a result of this and other crosses, Vogel produced and distributed to farmers two new highly productive non-lodging varieties.

In the spring of 1954 Dr. Norman E. Borlaug and his associates made their first crosses of the Norin-10*Brevor line, received from Vogel, with Mexican wheat varieties. In 1970 Borlaug received the Nobel Peace Prize for his work in bringing about the Green Revolution. Salmon's importation of Norin-10 made a significant contribution to the development of Borlaug's wheats.

Hundreds of thousands of acres of the U.S., Canada and Mexico were planted to these semi-dwarf wheat varieties.

From 1955 until his retirement in 1957, Salmon acted as Visiting Professor of Plant Breeding for Cornell University at the Philippine College of Agriculture, Los Baros, P.I.

After his retirement he made a trip to Paris for the Organization for Economic Development and Cooperation and has served as consultant to various organizations in the U.S.

In 1964 Salmon and A. A. Hansen published a book titled *Principles and Practices of Agricultural Research*.

NEILS EBBESON HANSEN



In 1959 Charles Sewery wrote, "Neils E. Hansen achieved more national and international acclaim than any State College faculty member to date. The span of his work at the College was from 1895 until his death in 1950 . . . Hansen's achievements were recognized both in scholarly journals and in popular publications such as *Coronet* and *Reader's Digest*

which tell how he risked bandits and braved desert heat and arctic cold in order to bring better living to the agricultural lands west of the Mississippi" (S-88).

Hansen, born in Rebe, Denmark, came to the United States in 1873. He was educated at Iowa Agricultural College and made eight plant exploration trips to Europe and Asia. In addition to many horticultural crops (fruits and vegetables), he brought many agronomic crops to the U.S. Included were: Swedish Select oats from Sweden, durum wheat from Central Asia, Hagi lespedeza from Japan, Ladak alfalfa from India and Turkestan alfalfa from Taskent. From Russia and Siberia he brought Kherson and Sixty-day oats, Odessa barley, Kubanka durum, Cossack alfalfa, yellow-flowered alfalfa, crested wheatgrass, Khursch millet, safflower, Red Orenburg, Red Russian, Red Veronezh, Black Veronezh and Tambov proso millets, and hairy sand vetch. He probably brought seed of smooth brome grass, also.

He also brought the fat-rumped sheep from Siberia that J. W. Wilson crossed with domestic breeds in an attempt to develop a breed of tail-less sheep. After several decades of crossing and back-crossing, some lambs were born with short tails and others with normal tails. Although the tail-less characteristic was desirable, it was felt that the advantages gained would not offset the cost of developing animals that bred true for this trait. The flock was disbanded in the 1950s.

The first overseas trip was a 4-month journey in 1894 when he visited eight countries and spent 3 weeks studying the agriculture in European Russia. The expedition may have been suggested by V. L. Budd, one of his teachers, who had collected fruits in Russia in 1882 (Bul 141).

In 1895 Hansen received an M.S. degree from Iowa State and was hired as Horticulturist at South Dakota State.

While Hansen was at Ames, James Wilson was Director of the Iowa Agricultural Experiment Station and his son, James Wilbur Wilson, was a graduate student who may have become well acquainted with Hansen. The acquaintanceship may have been an important one.

The elder Wilson was U.S. Secretary of Agriculture from 1897 to 1913. His son served as his private secretary from 1897 to 1900 and served as Director of the South Dakota Agricultural Experiment Station in 1902-1938 (Bul 665).

Hansen became the U.S. Department of Agriculture's first plant explorer. Plant Introduction Number 1 was a cabbage, *Brassica oleracea*, sent from Moscow, Russia, by him in 1898 (Bul 665).

The first USDA expedition lasted from June 1897 to March 1898. The itinerary included Eastern European Russia, Turkestan, Western China and Siberia. The overland journey by wagon and sleigh extended 2,000 miles from Tashkent, Turkestan, to Omsk, Siberia, via Kuldja in Western China. Five freight carloads of seeds and plants were sent to the plant introduction office (Bul 141).

Seed of Turkestan alfalfa, millet and several proso millets obtained on this trip was seeded at Highmore in 1899. Seed of durum wheat obtained at more than a dozen locations was planted at Highmore in 1903 and may have been planted at Mellette in 1901. In 1905 he provided alfalfa seed from 19 sources for the planting of square-rod plots at Highmore.

A second USDA expedition started in July 1906. Over 300 lots of seeds and plants were obtained on the 6-month trip around the world by way of England, Denmark, Lapland in Northern Norway, Sweden, Finland, Siberia, Manchuria and Japan (Bul 141).

A third trip for the USDA was made in 1908. It lasted 8-months, beginning in June 1908 and ending February 10, 1909, for the purpose of collecting more seeds of new forages, especially alfalfas and clovers in Siberia.

Hansen wrote that he found the northern limit of one alfalfa and one clover to be in Siberia between Verkhoyansk (latitude 68 degrees north and a recorded minimum temperature of -90.04 degrees F) and Yakutsk (62 degrees north latitude with a recorded minimum temperature of -83.92 degrees F). In this region the subsoil remains permanently frozen.

Hansen encountered a backward season and an epidemic of Asiatic Cholera in Russia and Siberia, but he obtained some 300 lots of seeds and plants. His homeward trip was through the Caucasa, the Mediterranean Region and Morocco of North Africa (Bul 14).

On Mount Lycabettos at Athens, near Mars Hill on which the Apostle Paul preached to the Athenians, Hansen gathered the wild seeds of the largest representative of the *Medicago* genus (alfalfa) that often grows to 10 feet. He also found these plants growing in cliffs near the outskirts of Naples, Italy. "The plants seemed to flourish in the driest possible crevices in almost perpendicular cliffs where, apparently, no water could get to them," Hansen wrote. "*Medicago arborea* appears of value in hot, dry places where other plants will live, but its greatest value is perhaps to be looked for from the standpoint of plant breeding."

About this time U.S. Secretary of Agriculture James Wilson said of Hansen, "He is an intelligent, intrepid fellow, full of resources, and nothing stops him. When he sees anything of value he knows it, and when he goes after a thing, he gets it" (Bul 665).

Hansen had become Vice Director of the Experiment Station by 1906 and had established a good reputation in the state. On March 3, 1911, the South Dakota Legislature appropriated \$2,000 for his use in testing the new alfalfas from Russia and Siberia. He advertised offering ten plants to each of the first ten applicants in each county. Over 800 applications were received the first year. During a 2-year period he sent ten transplants to upwards of 1500 farmers to space plant in their gardens for maximum plant growth and seed production (Bul 141).

During a 3-week period in 1912, he conducted demonstrations in many parts of the state to show how alfalfa seedlings could be transplanted by hand or with a modified vegetable crop planter (Bul 141).

He became convinced that these alfalfas could be used as a cultivated crop for hay and pasture or as wild plants in native ranges of the Prairie Northwest (Bul 141).

In 1913 the South Dakota Legislature appropriated funds for another trip. The major accomplishment was to obtain 3,200 pounds of seed of Semipalatinsk yellow-flowered alfalfa, much of which was immediately distributed for planting (Bul 665).

In a bulletin written in 1913, Hansen wrote: "It is worthy of note that the many failures in farming in the semiarid regions of the West are due to the fact that the plants cultivated are from the milder regions of Central Europe, showing that it is unwise to farm in a dry, cold climate with wet, warm climate plants. This is a very fundamental proposition, but the farmers of America have spent hundreds of millions of dollars in a vain effort to acclimatize certain plants."

N. E. Hansen made two trips to the Soviet Union after 1930 and was accompanied by his son, Carl, on the last trip in 1934. He was invited by the Lenin Academy of Agricultural Sciences to represent America at a 4-day celebration and national holiday in Michurinsk during which his friend Ivan Michurin, was presented the Order of Lenin to honor him for 60 years of research and breeding of horticultural crops. Hansen delivered an address in the English language with N.I. Vavilov as interpreter (Bul 665).

In 1980 Ross wrote: "Hansen heard the first paper presented on hybrid vigor at a meeting of the American Genetetic Association. He believed that crossing of blue- and yellow-flowered alfalfas would lead to improved varieties and he planted both types of alfalfa in a crossing block in 1914. Thirty-five years later, germ plasm from that block was included in a breeding program that produced the first pasture-type alfalfa produced in South Dakota. It was used successfully in mixtures with grass for tame pasture and as a wild plant in native range to improve production and quality of rangeland.

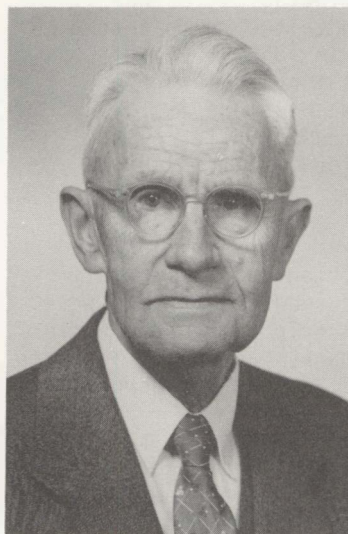
"I remember when visiting him with Wayne Adams. We were discussing what needed to be done to obtain an agronomically suitable drought-resistant alfalfa for the western ranges in South Dakota. He made the remark that we had the material at hand now in the yellow-flowered alfalfa which was suitable except for its inability to retain seed. He still exemplified his former vision and daring in his suggestion to obtain money from the legislature sufficient to establish an alfalfa breeding farm of 600 acres. Among space-planted alfalfa plants in that number there would be four or five which would retain their seed. These could be incorporated into a new drought-resistant variety.

"In the summer of 1948, after Wayne Adams had been reading the old bulletins written by N. E. Hansen, we were stimulated to take a trip through the northern part of Western South Dakota to locate some of the places where Hansen had sent yellow alfalfa plants some 30 years before. On that trip we never did find any of the actual fields but did find yellow-flowered alfalfa in various locations that must have spread from original plantings made many years before. Some of the plants were widecrowned, even as wide as 18 feet in diameter. They could be seen as yellow patches on the distant horizon. Some had hybridized with purple-flowered alfalfa so a diversity of forms were found. N. E. Hansen's great footprints in Western South Dakota are still marked by yellow-flowered alfalfa even now, after another 30 years have passed. These remain as valuable sources of rangeland alfalfas that will still be exploited in the future."

Hansen was named Professor Emeritus in 1937, but he didn't forget about alfalfa. A plaque in his honor was placed in front of the Horticulture Building on August 25, 1949. The plaque honors Hansen for his many new fruits, vegetables and grasses and concludes with "His efforts provided the people of South Dakota the means through which they enjoy a better living."

"We should 'hitch our wagon to a star'," Hansen wrote, "but should be careful to pick out the star that is going the right way for our purpose." He picked the right star for the work he did 80 years ago has changed South Dakota dramatically.

ALBERT NASH HUME



A.N. Hume was born December 3, 1878. He was raised in Indiana and attended Purdue University. During the summer of 1897 he came to South Dakota and worked on the Tom Lowery farm near Doland. He then went to Illinois where he worked with corn. In 1906 he again came to South Dakota to conduct a 3-hour corn school at the first meeting of the Corn Growers and Breeders

Association. He also judged the corn show.

Hume obtained his Ph.D. degree at Goethegen, Germany, and returned to Illinois. He was encouraged by Mr. Schoof, who had moved to South Dakota from Hume's home town, to give South Dakota the benefit of his talents. In June 1911, he came to SDSC as the first Head of Agronomy and the second Supervisor of Substations. He also inherited the office of Secretary of the Corn and Grain Growers Association.

Hume regarded the soil as a bank that supplied plant food for crop production. He emphasized that continual withdrawals by crop production would deplete reserves and that deposits must equal withdrawals in order to maintain a balance for future generations (Bul 139).

He employed J. G. Hutton, a soils man, on July 1, 1911, to start soil fertility investigations. They also realized that many soil types existed in South Dakota and believed that crop and soil management practices would not be the same for all of them.

In 1912 Hume called for a soil survey to delineate major soil differences so that experimentation could be conducted to determine the best management practices for each. A soil survey program was initiated in 1919 Hume was the first Director of Soil Surveys and Hutton took charge of the work.

"Knowledge is not knowledge until it is disseminated," Hume often said. In 1912 he suggested that numerous demonstrations be conducted to show new farming techniques to farmers (Bul 139).

He became the first County Agent Leader a year before the Cooperative Extension Service was formed. While Hume believed in the purposes of the new service, he believed they should be performed by the Experiment Station.

His tenure began during the drought of 1910-1911 and he was cognizant of climatic variations from year to year. To overcome the environmental variables, he emphasized the need for long-term experiments in order to obtain reliable information. During his first spring as Superintendent of Substations, he modified the previously established crop rotation experiments at the three substations to include "complete soil investigations." These experiments were continued for almost a quarter of a century and were not suspended until a reduction in funds made it necessary to do so.

He supervised the establishment of a fourth substation at Vivian in 1913, where a 10-year crop production experiment was conducted. His long-time studies on dates and harvesting prairie hay, started in 1942 at Cottonwood and Eureka, were continued until the substation at Eureka was closed in 1971 and until 1979 at Cottonwood.

Though Dr. Hume was replaced as Department Head in October 1943, he initiated rate and date of corn planting studies at Highmore and Brookings in 1945. The experiments were terminated 10 years later.

Dr. Hume hired Dr. John E. Grafius in 1941, two years before Hume retired as Department head. Grafius was small grain breeder at SDSC for 12 years. He went to Michigan State University and became a distinguished scientist.

"Dr. Albert Nash Hume was a gentleman and scholar of the old school," Grafius wrote in 1979. "Coming out of Illinois he assimilated the philosophies of scholars such as Davenport and Hopkins. He completed his Ph.D. at Goethegen. This was about the time of the rediscovery of Mendel's laws by Correns and Tschermak and Dr. Hume had the thrill of hearing Correns lecture on Mendelism.

"Dr. Hume's 'old world' type of courtesy and manner of speaking frequently came as a shock to students and younger members of the staff. Most of us, came to realize, however, that if we listened carefully there was a message. Sometimes we learned this the hard way. Dr. Hume will be remembered as a teacher and as a

friend. Among his most informative research efforts I would list his long time rotation experiments and his prairie hay management studies."

This writer, who took Crop Breeding I from Hume in 1940 and shared an office with him from 1947 to 1952, remembers Dr. Hume as a rather small, quiet, soft-spoken elderly gentleman with steel gray hair that he parted on the side. He wore horn-rimmed glasses, a hearing aid and a grey business suit. Dr. Hume is remembered for his broad field of abundant knowledge and for his desire to not only gain knowledge but to impart it to others. His specific interest in corn was one of the reasons that it became a major crop.

Though Hume had a distinguished career, he must have had some disappointing and perhaps some frustrating times. He was a staunch advocate of Extension and was the first County Agent Leader, but G. W. Randlett was named as the first Extension Service Director. Perhaps Dr. Hume did not want the job. In March 1923, he was present at the Board of Regents meeting when they decided to form the Agriculture Division and hire a Dean. C. Larsen got that job. Meager budgets during the 1930s made it difficult to keep good staff members and conduct good research. By 1938 Dr. Hume had a quarter century of administrative experience but I. B. Johnson became Director of the Experiment Station.

Finally in 1943, Dr. Hume was replaced as Department Head. He remained undaunted and continued to work. He conducted an excellent 10-year study on the rates and dates of planting corn. He was less active during his later years and passed away at his home on September 29, 1962. Dr. Hume was laid to rest in Greenwood Cemetary near the place he lived for over a half century.

JOSEPH GLADDEN HUTTON



Joseph Gladden Hutton, also of Indiana by way of Illinois, no doubt developed the same philosophies as Dr. Hume. His knowledge of soils and chemistry complimented Hume's knowledge of crops and genetics. Both were men of vision and together made a team seldom equalled.

Professor Hutton took charge of soils investigations on July 1, 1911. He and Hume shared the same philosophies about soils and Hutton immediately began investigations using manure, crop residues, and chemical fertilizers to determine the best ways of retaining a satisfactory balance of plant food in the soil. He instigated the use of chemical analysis to evaluate the results of research.

In 1919 Hutton took charge of soil survey in South Dakota and served as president of the national soil surveyors organization in 1928.

Professor Hutton was more than a top flight soils scientist. He was also conversant in the arts, especially poetry. A book of his poems was published shortly after his death in 1939.

His philosophy was revealed in 1937 by his own writing in Bulletin 325.

"Maintaining productivity of the soil is, without doubt, the most important material problem of any nation. The basic needs of humanity--food, clothing, shelter, and fuel--are, with the exception of fuel, obtained almost exclusively from the soil, not forgetting, of course, that the waters of the earth furnish important items of food to many people.

"When the soil fails to produce abundantly humanity suffers physical, moral and civic deterioration. Progressive, happy and prosperous nations are never hungry, ragged or cold, and their advancement depends largely upon whether or not they are able to manage their soils so that the physical needs of their people are satisfied. Famine, pestilence and war follow in the wake of depleted soils. These facts have been known since the dawn of civilization, but nevertheless, they do not seem to have received the universal consideration which they deserve.

"Thinking people who have long occupied the soils of a certain region have often learned something of the means of maintaining their productivity, but this is not always true, as the abandoned lands of our own nation can mutely testify. When good land was abundant and to be had for the occupancy, many people thought it easier to move to these new lands than to conserve their own.

"The time of cheap productive lands is past in-so-far as America is concerned. We must live upon the land which we already possess. This land must supply the needs of this generation as well as the needs of the generations to come. The soil is our most precious possession."

In 1940 the *Jackrabbit* SDSC's student yearbook, included the following memorial to

Professor Hutton entitled "Professor, Philosopher, Poet."

"Thousands of college students will long remember Joseph Gladden Hutton as a distinctive professor, a man whose love for his work, of life, and the soil was deep and consuming. He found an outlet for this love in his poetic nature. Because of that, students will remember him.

"Hutton was born on a farm near Monticello, Indiana, on November 3, 1873. He spent his early childhood on that farm and there learned to love the soil he studied, taught, and wrote about.

"Hutton served as soils professor at State for 28 years, coming to this institution in 1911 from the University of Illinois. He acted as assistant biologist at Indiana State Normal School from 1898-1900. From 1908-1911 he was assistant geologist at the University of Illinois, doing graduate work there. Hutton received his B.S. degree from the University of Chicago in 1908, his M.S. from the University of Illinois in 1910.

"As a leader, Hutton headed, or took part in various state and national soils organizations. As a professor and instructor he taught students and adults how they might make farm life easier. As a poet, he gave vent to his romantic love for the soil. He was among the better-known poets of South Dakota, his works appearing in several anthologies.

"It was on Saturday morning, September 23, 1939, that Joseph Gladden Hutton--professor, poet, philosopher--died. Death was due to a heart ailment."

In 1940 a volume of his poems was published. The foreword was written by A. N. Hume. Through his plaudits he not only lauded his friend and colleague, but gave an insight into himself and the complete harmony that existed in the Hume-Hutton team--a team unequalled by any other at the Land Grant College.

"This little volume is the result of philosophy of life. If it may reflect the conviction of one who verily made songs in the night, it will be abundantly worthwhile. In case it shall stir the imagination of a fairly weak-minded world into having a philosophy of its own, and also a conviction about the preservation of the soil, which is the material of all life, it will help to fulfill a prophecy.

"Joseph Gladden Hutton was born and reared on an Indiana farm, where he learned, as Hoosiers will, to observe the simple changes of day and night, winter and summer, earth and sky--with whom there is no variableness,

neither shadow of turning. He came by education there among the children of the folk in the common school, said farewell there to his mother, and learned to honor his father who as a soldier just naturally staked his life on what seemed right to him.

"The things the younger Hutton learned on the farm--digging post holes and ditches, and plowing furrows among the people of a rather unassuming community--were always his, though he learned much in after years. He graduated from three universities and won distinguished honor in them all. Scores, hundreds who knew him will assert that few men were so accurately informed in so wide a range of subject matter.

"The faith which he carried with him steadfastly into the early morning sunrise of last September twenty-third, was the same unspoiled, unshaken faith in the integrity of the universe, that he brought from the farm and enlarged along the way.

"Three thousand college students would tell that Joseph Gladden Hutton was a great teacher. It was his ruling passion to know the facts and to have them known by many. In the classroom he insisted that students learn "dry facts." Some of them did. Those who did and who were additionally inspired to get wisdom, and with it to get understanding made up so large a proportion of his students that they characterize his genius as a teacher. They form a brotherhood of the soil. He would wish this little volume to prompt them to 'carry on.'

"In recent years Mr. Hutton became convinced that people collectively are motivated as certainly by sentiment as by intellect. The poems in this little book are the result of his well-considered attempt to make such an appeal.

"When the word went out that Professor Hutton's voice was still, there came spontaneously suggestions and offers of cooperation to help in assembling and publishing these poems about the soil. Many of these suggestions came from members of Alpha Zeta, a number of whom were original members of Hopkins Club when Professor Hutton was then "Class Dad". They knew him when!

"Through the energies and willingness of the Alpha Zeta brothers the service of assembling and publishing the poems of the late Professor Hutton has been carried out.

Now they are yours--A. N. Hume."

The poems included in the publication were "Soil and Soul," "The Worn Out Farm," "Hunger," "Compensation," "Harvest Time," "A Toast," "The Strike," "All Through The Night," "What Shall We Do With It?," "What Constitutes a College?,"

"A Student's Prayer," "World Loyalty," "Religion," "Bethlehem," "From Good Friday to Easter," "The Kingdom Comes," "Just This," "March," "The Watch in My Pocket," "Life," "Our Heritage," "Choice," and "Dust and Destiny."

These titles tell that he was a religious man who was truly a professor, a philosopher, and a poet.

EDGAR S. McFADDEN



The descendent of a Scottish immigrant, Edgar S. McFadden was born February 3, 1891, near Webster, South Dakota. His life history was written by J. D. Radcliff and printed in the September 1946 issue of *Farm Journal* and repeated in the *Minneapolis Sunday Tribune* (MST) on

October 26, 1947.

The Man Who Gave Us Bread

Edgar S. McFadden is a quiet little man, a scant five feet, two inches tall. He has mild blue eyes, and a fringe of curly grey hair around a bald spot. Even in his home town, College Station, Texas, very few people know him. Yet a good case can be made for nominating him the most important man in the world today (FJ).

Thanks to his work, 25 million people are eating who would otherwise be dead or dying of starvation. During the war years he saved American farmers an estimated \$400 million (FJ).

McFadden's development of disease-resistant wheat is a stirring saga of agricultural research. The job began before World War I, and was completed just in time to add hundreds of millions of bushels of wheat to stockpiles during World War II. The food situation is bad enough now. Without McFadden's work, it would be desperate (FJ).

McFadden's father, an up-state New York school teacher, migrated to South Dakota in 1882, and son Edgar was born in a claim shanty in the boulder-sprinkled Coteau Hills during a blizzard on February 3. The shanty served both as living quarters and granary with seed for the 1891 crop. His cradle was a grain bin filled with seed wheat (MST).

Wheat was life to the McFaddens. A good crop meant plenty, a crop failure bankruptcy. Anything that was an enemy of wheat--hail, drought, early frost, rust, root rot--was an enemy of family security (FJ).

Young McFadden--"Stub" to his family, "Mac" to everyone else--learned this early in life. When he was 13 years old, a bull gored his father, and nearly killed him. The boy had to put in the crop. It looked good, promised to make 40 bushels to the acre. Then the stem rust epidemic of 1904 struck. Pitted by fungus, stems broke and fell over. Wheat kernels that should have been fat and heavy were shriveled and dry. Instead of making 40 bushels an acre, the crop came in at five (MST).

Spores of this disease, microscopic goose eggs, brick red, spent the winter in Texas. When summer came, they rode warm winds north. In a 24-hour period in bad rust years, as many as 600,000 of these spores would rain down on a single square foot of Dakota farmland! The ones which landed on wheat grew, sucked the life from the plant (FJ).

It was in 1911 that he got the first idea of trying to develop a wheat to withstand rust. In 1925 he told the Webster Kiwanis Club, "These ideas came to me as a result of having spent the greater part of 3 years in the desert region of our Southwest. I returned to South Dakota just in time to witness the big drouth of June, 1911, followed by an epidemic of stem rust, which practically wiped out everything that the drouth had not taken. It is little wonder that I acquired a lasting impression of the vital importance of controlling drouth and plant diseases. It seemed that there would ultimately come a time when a drouth like 1911, or a country wide epidemic of stem rust like 1904, would mean a nation-wide, and possibly a world-wide famine."

Walking through the devastated wheat fields with a few stalks of diseased grain in his hand, McFadden noticed in a nearby barley field a few stalks of Yaroslav emmer standing strong and erect despite the rust (MST).

He knew this tough, fibrous emmer was worthless stuff except as stock feed; it had to be ground or soaked before even pigs would eat it. Still, it wasn't susceptible to rust (FJ).

In one hand he held the emmer. In the other the rusted wheat. Seated on a rock in his father's field, he symbolically crossed the emmer and the wheat. He didn't know it then but that was the basis for Hope wheat (MST).

In 1925 he said, "This idea filled my mind in the fall of 1911 when I started for State

College to learn something about botany, field crops and plant diseases that would be of value for finding or developing drouth- and disease-resistant crops.

"In the spring of 1913, I obtained a summer position as a field assistant on the Experiment Station and in 1915 I succeeded in getting the Agronomy Department to hire me as their official plant breeder and turn me loose for the purpose of starting any experiments in plant breeding that I saw fit."

He talked with one of his professors. Mightn't it be possible to breed this worthless emmer with good bread wheat--say mighty Marquis? "Why don't you try it?" the professor suggested (FJ).

Older men of science had said that this could never be done, because emmer had 28 chromosomes, bread wheat 42. Any resulting progeny of such a mating would be sterile. Fortunately, McFadden hadn't heard of this (FJ).

McFadden lived in a rooming house, known as the Nelson House, on 8th Avenue and 9th Street, according to H. E. Cheever, long-time Brookings banker and friend of McFadden. Mac asked Mrs. Nelson if he could use a corner of her garden.

She consented and in the spring of 1916, McFadden planted a row of emmer and a row of Marquis wheat. It was touch and go whether the mating would come off. Marquis flowered early, emmer late. But there was one very short period of overlap. It fell on the Fourth of July (FJ).

Other students were going on a picnic. McFadden stayed home. With tweezers he castrated the emmer flowers--removing the anthers, or male parts. Then he dusted in pollen from the Marquis flowers and wrapped the heads in tissue paper to prevent any accidental pollination. All that hot day he toiled (FJ).

Though he desperately needed the \$2 or \$3 a day he could have earned working in the harvest fields, he stayed behind at the college where he earned \$45 a month, out of which he paid his room and board, in order to work on his project (MST).

That fall there were a few poorly-developed seeds from the matings. There was no guessing what magic blood lines, if any, they contained. It would take several years to find that. Still there was a terrible urgency about the whole matter (FJ).

The year 1916 had been the worst rust year in history. The plague swept northward through the U.S. wheat belt, destroying 200 million

bushels of grain. Then it moved into Canada to destroy 100 million more, and bankrupt more farmers (FJ).

He saw a ray of hope in the few seeds and could hardly wait for the spring of 1917 when he could plant them (MST).

McFadden planted his handful of shriveled, unpromising-looking seeds in the spring of 1917. Day by day he watered them, waited for them to come up. Obstinate, they refused. It looked as though they were sterile, valueless. Then one green sprout showed! Only one (FJ).

On this slender thread hung the lives of millions of human beings--who are eating today because that seed sprouted. Grandchildren of that one seed are today growing on an estimated 15 million acres of U.S. and Canadian farmland--a wheat field larger than Switzerland (FJ).

That single seed, representing a cross which scientists said could never succeed, produced 100 shriveled kernels. These went into the ground in the spring of 1918. That fall McFadden was in an Army camp on the Pacific coast (FJ).

Cheever remembers that Mac asked his commanding officer for permission to go back and harvest his wheat. Of course, he was turned down. He apparently had a change of commanding officers. He then wangled a leave, a "harvest furlough". He didn't trouble the Army with details about how big his "harvest" was--a few rows of wheat a dozen feet long! (FJ).

The war over, he came back to a job with the U.S. Department of Agriculture at the Experiment Station at Highmore, South Dakota.

In 1925 McFadden wrote, "I remained with the Agronomy Department at Brookings until the spring of 1918 when I obtained a (USDA) position in charge of cereal investigations on the Highmore Experiment Station. My plant breeding work was continued at Highmore until the fall of 1920. In June the Department of Agriculture announced that a big cut in appropriations would make it necessary to withdraw its support from the Highmore Station. They had a good position for me in one of their head offices in Washington, D.C., that would pay me the highest salary permitted by the Civil Service regulations and a bonus of \$20 a month. I undoubtedly would have accepted their offer but I had started out 10 years before to develop drouth- and disease-resistant crops for Northwestern conditions. I wrote that I was more interested in certain problems in South Dakota than I was in high salaried positions in the East.

"I had a talk with the Head of the Agronomy Department and was informed that there were no state funds available for plant breeding, but there was an opening for an instructor. My reply was that I was more interested in the education of wheat plants than I was in the education of the youth of South Dakota, and that if there was no possibility of continuing the work on state funds, I would go back to the farm and continue it on my own resources. Accordingly, I returned to the old home farm in Day county in the fall of 1920 and brought much of the more promising plant breeding material along with me."

There is no way to hurry the tedious, painstaking business of plant breeding. You grow your crop, save the promising plants and throw the unpromising ones away. As soon as one problem is solved another comes up. Thus, McFadden's wheat was good as far as rust was concerned. But it was susceptible to root rot. And it made dark flour--a mark against any bread wheat (FJ).

McFadden went to work on these shortcomings. He staked off a nursery plot near the farmhouse and set up a laboratory on the back porch. There was a borrowed microscope for identifying rust spores, a kitchen table work bench, a sagging cupboard. He made an incubator for rust spores out of an old trunk and a piece of storm sash. Obsessed with the mighty idea that he could whip the rust plague, he puttered in his laboratory by kerosene lamp long after dark (FJ).

While he was engrossed in his backporch science, things went badly on the farm. He was burned out by drought in 1921, hailed out in 1922, rusted out in 1923. He even saw this epidemic coming--saw it with his microscope. He trapped on vaseline slides the brick-red spores that were raining down on the wheat fields (FJ).

McFadden told his neighbors that a terrible epidemic would break in 2 weeks. For a long time they had suspected McFadden was slightly potty, puttering on the back porch with a microscope. Now they knew it! But 2 weeks later rust arrived, the worst epidemic Day County had ever seen up to then (FJ).

Grain was broken over everywhere, that is, except in McFadden's nursery. His test rows of emmer-Marquis cross stood strong, erect. The rust detoured around them. This was triumph, but it didn't help the condition of the McFadden bank account (FJ).

He begged the Agricultural Committee of the State Legislature for funds to continue the work, but got nowhere. Since the farm was already mortgaged to the hilt, banks

turned a deaf ear. There were two sources of money left: his household goods and his insurance policies. With Scotch persistence, McFadden threw in everything for one last gamble (FJ).

By 1923 after seven generations of selection of his hybrid, he came up with two promising selections. Not having money for laboratory tests, he made his own gluten tests by chewing the wheat into gum (MST).

The two selections were H-44 and H-49. H-44 was a few days earlier and consequently was sent to plant breeders in Canada. He gave the name "Hope" to H-49 (MST). It was a good name, for the wheat offered little more than Hope. There were all sorts of things wrong with it. It produced low yields of light-weight grain. It was highly susceptible to spring frosts (FJ).

Yet Hope had its good points, too. It was resistant not only to stem rust, but to leaf rust and five other major wheat diseases. It contained 42 chromosomes, the same number contained by all bread wheats, so breeders could easily cross it with high-yield wheats (FJ).

McFadden was not hungry for personal glory. He sent small packets of Hope wheat to wheat breeders all over the world, to speed up the work. In 1929 he rejoined the USDA, his present employer (FJ).

He was wheat breeder from 1930 to 1935 on the Redfield Station, which the USDA had established in 1914 to conduct alfalfa improvement studies.

For awhile in the mid-30s it looked as though McFadden had lost the race. Researchers at the University of Minnesota produced a magnificent wheat named Thatcher, which was resistant to stem rust. But it lacked resistance to leaf rust. In bad years, leaf rust would lop ten bushels of wheat off an acre. Hope resisted both rusts (FJ). Thatcher was developed from a cross involving Iumillo durum developed by John Cole.

Just as World War II started, a host of Hope derivatives--grandchildren of McFadden's original cross--began hitting the market. Superior new wheats like Rival, Pilot, Mida, Cadet began crowding Thatcher out of wheat fields (FJ).

The rust epidemic of 1935 prompted the USDA to move him to Texas A & M. McFadden proved that rust started in Texas and was carried by the winds all the way to Canada (MST).

"We've got to stop recurring epidemics" he said. "And the best way to do that is to build a barrier of rust-resistant wheat clear across Texas" (MST).

While down there he developed six new varieties (MST). Austin was planted on a million acres in Texas, much of it on land that could never produce wheat before because of the rust pestilence. Another Hope derivative took over almost the entire California wheat belt. Fifteen million acres are now given over to Hope grandchildren in the north (FJ).

It is difficult to assay Hope wheat in terms of human hunger, but the money side is easier. A. W. Erickson, Minneapolis crop reporter, estimates that Hope derivatives saved farmers in the Dakotas and Minnesota \$135 million in 1944 alone. A rust epidemic on the march would have destroyed that much grain (FJ).

Everything considered, it appears that \$400 million is a conservative figure for savings during the war years (FJ).

For all the millions of dollars he has put in the pockets of farmers, McFadden has profited not a penny. New wheats aren't patentable. He lives modestly in Texas now, still fighting man's bloodless battle for bread (FJ).

By producing better grains especially adapted to the Texas climate, he feels that he might whip the rust problem once and for all. With Texas planted to rust-resistant wheat, the spores which cause the disease will have no place to spend the winter. At that point final victory will be won (FJ).

Though McFadden received little monetary compensation, he knew in his heart that he made a significant contribution to mankind. Others knew it too and honored him for it.

In 1946 he received the *Readers Digest* award of \$2,500 for "... exceptionally meritorious contributions to public welfare." The next year he was recognized by the Texas Chemurgic Council for "... distinguished service to agriculture", and in 1948 he was cited by the American Agricultural Association for "... outstanding service rendered to American Agriculture."

The farmers of Day County in 1947 erected a large granite memorial to McFadden on the grounds of the Lutheran Home in Webster, S.D. The engraving said in part, "The Farmers of Day County Herewith Seek to Perpetuate the Memory an Appreciation of One Day County Farmer, Agronomist and Plant Pathologist

EDGAR S. MCFADDEN."

McFadden lived 43 years in South Dakota and 25 in Texas. He died January 6, 1956 and was buried at College Station, Texas.

Though he made many significant contributions to agriculture none of them has had the impact of Hope wheat, a variety he developed because he didn't know it couldn't be done.

WALLACE W. WORZELLA



"Wally" Worzella was born at Plover, Wisconsin, in 1907 and spent his boyhood on a farm in that area. After receiving the B.S. degree at the University of Wisconsin he completed his Ph.D. at Purdue University in 1934. For the next 10 years he continued research at the Indiana Agricultural Experiment Station mainly with fertilizer and variety trials, as well as wheat breeding.

In 1943 he assumed the position as Head of the Agronomy Department at South Dakota State College. He never saw the difficulties, only the opportunities. So after a short time in South Dakota during which he travelled throughout the state and visited with farmers, he came to some conclusions regarding necessary programs that would increase yields and stabilize crop production in his adopted state.

In 1943, in addition to the department head, the staff included two men in soils and three in crops. Much of their time involved teaching soils and crop production courses, with little time available for research and meetings. He initiated programs directed towards increasing the research and teaching staff, providing adequate facilities, providing easy access for farmers to new grain and forage varieties, and establishing a team approach to solving problems.

Realizing that it would require several years to acquire adequate facilities and assemble qualified staff, Dr. Worzella immediately initiated a few activities to stimulate interest, and illustrate the value and significance of agricultural research.

While attending the Regional Oat Breeding Conference at Ames, Iowa, he was able to obtain 50 bushels of the new variety Vikota for the S.D. Agricultural Experiment Station. In 1944 it was planted on 17 acres and the 50 bushels produced 2,422.5 bushels of oats or

142.5 bushels per acre; whereas local varieties yielded from 30 to 40 bushels per acre. Many farmers visited this outstanding oat field and reflected upon the need for additional research so that South Dakota farmers, too, would benefit from improved varieties of all crops as well as from soil fertility, weed control and many other crop production and management practices.

In the soil fertility area, Dr. Worzella initiated some of the first fertilizer trials on farmers' fields in South Dakota. In 1944 he established a fertilizer trial on wheat in Day County and one in Grant County. He told how his daughter, Mary, age 6, assisted with the measuring tape to establish the borders of the experimental plots.

Worzella was a firm believer in the team approach in attaining goals such as hiring of new staff, planning for new facilities and developing new projects and programs. Involved on such teams and committees were Agronomy staff members, administration, Extension staff, farmers and representatives of industry. He delegated responsibilities to the staff members and had full confidence in their ability and performance. As Department Head he was always on "Tap" and not on "Top." His office desk was neat and his door always open for anyone to come in and give or receive suggestions.

His boundless enthusiasm made him a favorite speaker so he was constantly called upon to speak in counties throughout the state.

He believed in and encouraged the staff members to take vacations, and make them recreation and not wreck-creation. These often involved trips to summer meetings of the American Society of Agronomy held in Utah, California or Ohio, where sometimes the whole family participated. Other group staff activities involved Christmas parties, picnics, hunting for pheasants or deer in the Black Hills and fishing.

Dr. Worzella implemented staff and facility expansion by involving all of the staff together with U. J. Norgaard, the Extension Agronomist, and farmers from the S.D. Crop Improvement Association. Committees were set up to make proposals and suggestions relative to the nature of the staff; kinds of facilities; and statewide programs, such as Foundation Seed, soil testing, weed control, soil survey, crop breeding and crop and soil management. Final approval for additional staff, facilities, budgets and new programs was made by boards involving staff, administration, farmers and industry representatives. Following an extensive educational program by

the Extension Service, Agronomy staff, S.D. State Crop Improvement Association and at field days, the people of the state became aware of the potential of agricultural research in increasing and stabilizing crop production in the state.

As a result, they approached their legislators to convince them to increase state monies for agricultural research. With greatly increased funds, the facilities were greatly improved; the staff increased seven-fold; and new programs established, such as the Foundation Seed Stock Division, Soil Testing Laboratory, and soil survey and weed control programs.

As a result, an excellent research and teaching staff was provided with adequate means with which to develop many new crop varieties, to release thousands of bushels of new seeds to farmers, provide soil survey in many counties, and perform soil and seed testing services, and many other soil and crop management practices.

Aggressive agronomic programs, often the result of lack of communications, are sometimes misunderstood and result in criticism from citizens. Two such events illustrate this. The soil testing program was developed in 1948 and the laboratory established in the Agronomy Department. Soil samples obtained from fields throughout the state were sent to the laboratory for evaluation and soil fertility recommendations.

After several years of this service, a chemist at a state institution in Rapid City gained some supporters to try to set up soil testing in his laboratory to evaluate the soil samples from the western counties of the state. After conducting a joint meeting that included farmers from the area, Agronomists informed the gathering that soil testing was more than adding a few drops of acid to a gram of soil. It involved knowing soil surveys, geology, correlation of soil with yield trials, etc., before recommendations could be made. The meeting adjourned and all samples continued to be sent to SDSC.

The other event involved the growing of barley in the state. Field experiments showed that malting barley varieties yielded 25% less than feed barley varieties when grown in the western half of the state, so the recommendation to farmers was to grow malting barley only in the eastern counties.

Malting barley seed was scarce and the malting industry pressured the Board of Regents and the President of SDSC to revise the agronomic recommendations so that malting varieties would be approved for production throughout the state.

A joint meeting was held in the President's office and an Agronomist presented the research data from several years of variety trials conducted throughout the state. After the presentation of research data, I. B. Johnson, Director of the Experiment Station, stated, "Men, you have seen the results. If we cannot report the facts honestly, close the whole Agricultural Experiment Station". The meeting adjourned and the recommendations of the Agronomist were not changed.

In addition to the many responsibilities connected with being a department head, Dr. Worzella made research contributions by conducting pasture trials in cooperation with the Animal Husbandry Department. After the value of such work was demonstrated, a pasture researcher was hired.

He was also chairman of the Graduate Program Committee which prepared the first graduate study catalog for SDSC. He also obtained approval for the Ph.D. degree program in Agronomy.

Dr. Worzella presented many scientific papers at national meetings, held several offices and authored some 60 scientific publications. In 1956 he was made a Fellow of the American Society of Agronomy in recognition of his original contributions in agronomy and dissemination of knowledge concerning crops and soils which has contributed so greatly to general human welfare.

In a letter to the Board of Regents on April 18, 1957, John W. Headley, President of SDSC wrote, "Worzella is a most competent man. He is creative, a man of courage, industrious and is effective in his work. Dr. Worzella, serving as chairman of the graduate committee, has helped organize the graduate program to a point that it has attracted national attention because of its growth and its improved quality. This has been done in addition to handling the biggest department in Agriculture."

After President Headley died in November 1957, Dr. C. M. Crothers became acting president for a second time. He fulfilled a promise he made when he served in that capacity several years earlier. In 1952 Crothers told Dr. Worzella that he (Crothers) would be the next president and he wished to be the first to inform Worzella that he would recommend Worzella's dismissal to the Board of Regents.

However, Dr. Headley became president and served until his death. Early in 1958, during his second term as Acting President, Dr. Crothers fulfilled his earlier threatened action and recommended to the Board of Regents that Worzella be dismissed. The Regents followed the recommendation.

An editorial comment of the *Hamlin County Herald Enterprise* on the action of the Board of Regents epitomized the feelings of those who knew Dr. Worzella the best. "... it fired the one man whose competence and fitness for his post are proved; a man who commands national acclaim for his scientific ability; and a man of the type South Dakota constantly seeks--usually in vain."

To this may be added the loving esteem of members of the Agronomy Department and all others that knew him well.

Dr. John E. Grafius, for example, wrote "he was one of the most dynamic department heads I have known. His leadership qualities were unsurpassed."

During the following 15 years, Worzella conducted agricultural research, taught graduate students, did consultant services, and assisted in establishing agricultural departments in the Middle East and Africa.

Dr. Vernon Malan, of the SDSU Sociology Department, and his family visited the Worzellas while they were at the American University in Beirut, Lebanon, and reported the same devotion of the people on his staff that was so evident in South Dakota.

In 1970 the Lebanese government honored him with the Ceders of Lebanon Award for his outstanding service to agriculture improvement in that country. After his retirement in 1972, Worzella continued his consulting work on a short-term basis in Middle East and African countries.

Wally and Hazel retired near his original home at Plover where he built a beautiful home with his brothers in a newly developed area. A lake outside his living room window allows him to set a line and fish from the comfort of his favorite chair. Since retirement, he really hasn't had much time for fishing because of his involvement in the potato production business with his brothers. When showing visitors around the production area, his old time enthusiasm is just as evident as when he conducted tours of the Agronomy Farm at SDSC.

UFFE JENSEN NORGAARD

U. J., no one called him Uffe and few knew his middle name, was born in South Dakota and reared in Nebraska and Wisconsin. He returned to South Dakota where he served 32 years in the Extension Service and received the highest honor bestowed on an Extension employee.

According to his daughter, Ruth Norgaard Mogen, U. J. was the youngest of seven children born to the Reverend and Mrs. Peder Jensen.



All the children were given the middle name of Jensen and the surname of Norgaard. Reverend Jensen, the only one of seven brothers and sisters to immigrate to the U.S. from Denmark, was Pastor of the Danish Lutheran Church in Vigborg, South Dakota where his youngest son was born on August 6, 1891.

During the next 3 years the family served churches in Plankinton, Pukwana, Erwin, Hetland, Centerville, Ethan and Sioux City. They lived in St. Paul, Minnesota for 2 years then went to visit relatives in Denmark where U. J. celebrated his fifth birthday.

They lived in Davey, Nebraska until 1903 when they moved to Withee, Wisconsin, where U. J. finished grammar school and 2 years of high school. He lived with a brother in Harlan, Iowa, where he graduated from high school in 1909.

He attended Danish folk school, Danebad, at Grand Island, Nebraska until his mother became seriously ill. After she died he enrolled in 1913 at the University of Wisconsin. After 2 years of college and one year of teaching Vocational Agriculture at Boscobel, Wisconsin, he was drafted for service in World War I. He was sent to France and remained for some time after the Armistice was signed to guard prisoners. He graduated from the U of Wisconsin in 1920.

For 4 years U. J. was Vocational Agriculture Instructor and coach at Salem, South Dakota. He knew little about coaching, but his ability to meet and solve difficult problems began to emerge. A farmer was hired to do the actual coaching. Their basketball team was runner up to Yankton in the 1925 state basketball tourney. The same players won the championship in 1926.

While at Salem he married Dagmar Hansen, a long time acquaintance from Withee, on U. J.'s 31st birthday, August 6, 1922. Their daughter Ruth was born at Salem in 1924. Because of severe headaches, U. J. was advised to spend more time out of doors. In 1926 they rented a farm at Barren, Wisconsin. During the summer he wrenched a knee while helping a neighbor harvest potatoes. Inflammatory rheumatism, which had bothered him on two previous occasions, caused him to seek other employment.

U. J. became the County Agent in Sully County on October 15, 1926. Dagmar and Ruth went to Withee to await the arrival of Daniel. During the winter they took the train to Onida.

U. J. recognized the value of good seed and farmers in Sully County were soon raising certified seed.

While at Onida he learned the hazards of drought, grasshoppers and soil erosion. He also learned how to cope with them--lessons that he constantly strove to teach to others. He developed the philosophy that any good program could be implemented if the people understood the need for it.

In 1938 he was asked to coordinate the state grasshopper program. On February 16, 1939, he became Extension Agronomist and moved to Brookings. He was elected secretary of the South Dakota Crop Improvement Association. Because of his conviction that best results were obtained by working with organized groups of informed persons, he organized 20 County Crop Improvement Associations during his first year as Extension Agronomist.

During the mid-1940s Norgaard became one of the "three musketeers". Norgaard, Leonard Ladd, Extension Soil Conservationist, and George Gilbertson, Extension Entomologist, held a series of crop hazard schools. In 1945, for example, they held 33 meetings where they discussed ways of overcoming the hazards of too little moisture, soil erosion and grasshoppers.

John E. Grafius, who was small grain breeder in the Agronomy Department from 1941 to 1953 wrote:

"Every Agronomy Department should have a U. J. Norgaard. U. J. was tall, thin and slow of action, but when he spoke, his deep voice conveyed words of wisdom.

"The phrase 'Farming around July' came from Norgaard. It was the result of his experiences in Sully County during the thirties . . . 'if we just had earlier small grain varieties, we could beat the July drought. And sorghums become dormant in July and then recover in August if we get rain. Lets farm around July.'

"In order to do his job of Extension, he needed something to extend and he made sure he got it . . . Whenever a new staff member arrived, U. J. would spend hours indoctrinating him with the facts, fables and problems of South Dakota."

U. J. was a member of the Worzella-Norgaard team, comparable to the Hume-Hutton team of an earlier era.

In 1980 J. G. Ross, who had been a grass breeder in the Agronomy Department since 1947, wrote:

"The combination of vigor, ideas and enthusiasm residing in Worzella coupled with the philosophy and knowledge of the state of Norgaard . . . provided a master plan for accomplishing the necessary changes to bring about increased stability through consistently increased yield of crops."

"The other member of the team was E. G. Sanderson, an idealistic farmer who took a great interest in . . . Agronomy. He was the means by which ideas were carried to the legislature . . ." New staff members were hired, new buildings built and new programs implemented.

In 1954 the superior service award--one of the highest given by the USDA--was presented to U. J. Norgaard in Washington, D.C. by Secretary of Agriculture Ezra Taft Benson.

The award was given for "outstanding accomplishments in seed improvement" and for "motivating farm people to adopt better crop production and management practices."

The news story added: "He is best known for his work in organizing the South Dakota Crop Improvement Association and developing the state weed program."

The International Crop Improvement Association made him an honorary member in 1962. The South Dakota Crop Improvement Association also presented him with a plaque for many years of dedicated service. He served as secretary of the latter group for 25 years--6 years after he was retired as Extension Agronomist Emeritus in 1958 at the age of 70.

On November 15, 1972, the Brookings Register carried an editorial entitled "We need more U. J.'s" It said in part:

"Few men have contributed more to the well-being of agriculture in general and farming in particular than U. J. Norgaard . . . who passed away earlier this month."

"South Dakota has yielded its share of agricultural leaders. Few have exhibited more dedication than U. J. as he was known throughout the agricultural community. Most of the outstanding farmers that have retired during the last 10-15 years knew him personally and many solicited his advice.

"Even more important, many farmers who never met the man are undoubtedly benefitting from his efforts . . . Farmer members of the (SDCIA) Board of Directors suggested that he

help organize county units . . . and (improve) the seed certification program of the state.

"So it was recommended that each county organization establish a local (variety) demonstration plot so that area farmers might compare for themselves the performance of crop varieties being promoted for the area.

"Mr. Norgaard also helped hammer out the details of the certified seed program (and foundation seed program) an effort designed so that farmers would not be charged unreasonable prices for newly developed crop varieties.

"During his years as secretary, the group (SDCIA) was influential in establishing a Soils Testing Laboratory, Agronomy Seedhouse (and and Greenhouse), plant pathology (office-greenhouse-laboratory complex) and Foundation Seed Stocks building. All have been important cogs in the wheel of agricultural success in the state."

A news story from the same paper stated in part:

"Norgaard helped draft the legislation which created the South Dakota Weed Board; he helped organize the Seed Certification Service and the Foundation Seed Stock Division."

In 1981 W. W. Worzella, who was Head of the Agronomy Department during most of the time that Norgaard was Extension Agronomist wrote:

"U. J. Norgaard's life was dedicated to serving his fellow man. As an Extension Agronomist he had the ability to actively involve many people in solving many difficult agronomic problems and executing the solutions. He firmly believed that only through education and understanding of crop management and production problems and their solutions, that farmers would adopt improved practices. He was a continuous student not only in subject matter, but also in advanced Extension procedures.

"Though some regard South Dakota as a 'high risk' state for agriculture, U. J. believed that many failures were caused by the use of unadapted crops and mismanagement of crops and soils. He helped county groups organize County Crop Improvement Associations which were organized and run by local farmers. He then used these groups to help disseminate information about seed certification, foundation seed, new improved varieties, weed control and other management practices.

"Mr. Norgaard was a team worker and an excellent organizer, an effective ingredient in implementing state-wide agronomic programs. He was well-known and respected by farmers, seedsmen and his peers.

"His contribution to the development and improvement in agriculture and South Dakota's increased wealth has been surpassed by very few."

U. J. considered himself as an adult teacher. He declined offers of other positions with much higher salaries. He loved South Dakota; it came first and money was secondary. It was a sad day in November 1972. South Dakota lost an outstanding citizen.

CLIFFORD JAMES FRANZKE



Franzke was born at Bijou, South Dakota on April 27, 1896. He had perhaps the most distinguished career of anyone to major in Agronomy at SDSC.

He was a messenger for his Company Commander during World War I and was wounded in action. Upon receiving a discharge he lived in East Men's Hall

at SDSC, which was built for the housing of disabled veterans. He attended the School of Agriculture, later enrolled in College and worked in the Agronomy Department.

While in college he met Rose M. Norman of Brandt, South Dakota. He was appointed to the staff of the Agronomy Department on April 1, 1924 which was before he graduated on June 2. Cliff and Rose were married on October 4. In 1925 Clifford James Franzke, Jr. came to live with them and Yvonne Ardell joined the family 16 months later.

During the late 1920s and 1930s Franzke was Assistant Supervisor of Experiment Stations. At first he worked primarily with small grains; however, during the early 1930s he supervised experimentation on methods of controlling field bindweed on West Farm and at the three substations.

During the 1930s Cliff Franzke selfed several open-pollinated corn varieties adapted to Central South Dakota. He produced the first seven inbred lines and the first four double-cross hybrids developed in the state. They were instrumental in moving the corn belt farther north and west and served as a basis for the formation of Sokota Hybrid Producers

Inc., a seed corn company that processed over 350,000 bushels, sold over 140,000 bushels of seed and grossed over \$4 million in 1978.

During this time farmers suffered livestock losses from grazing sweet sorghums. Franzke set about solving the problem and released 39-30-S in 1937, the first low acid variety.

Eight years later he released Rancher which contained only 10% as much hydrocyanic acid as 39-30-S. These are the only two low prussic acid varieties in the U. S. and have been extremely useful to cattlemen who wish to graze sorghum.

He developed two grain sorghum varieties, Norghum released in 1949 and Reliance in 1953, and the first six sorghum hybrids. Most were characterized by open panicles, which dried more readily on the stalk, and elongated peduncles to facilitate straight combining.

The new varieties could be harvested with a combine, were adaptable to a large area, produced good yields and expanded the sorghum growing area many fold in the Great Plains. Grain sorghum became a competitor of corn in South Central South Dakota (Hardies).

John E. Grafius, who was a co-worker for a dozen years in the 1940s, wrote in 1979, "Dr. Hume hired Clifford Franzke shortly after the close of World War I (1924). Cliff had lost an arm during the war but he did more with one arm than most could with two, figuratively and literally.

"Cliff developed the inbred lines of corn which formed the first Sokota hybrids. He developed several outstanding lines of grain sorghum, the first low prussic acid forage sorghum and a Pythium root rot resistant strain of crested wheatgrass as well as improved strains of fescue and wheatgrass. All in all his is quite a record of achievement."

During the 1940s he took charge of the soybean project and evaluated dozens of soybean varieties for their potential use in South Dakota. He also began to use colchicine in his sorghum breeding program. In 1973 E. W. Hardies wrote:

"The discovery that colchicine, a common drug, doubled the number of chromosomes led to the use of this drug. The objective in plant improvement was to produce variation. The common methods of producing variation were crossing, inbreeding, and the production of mutations. Franzke developed the technique of using colchicine to create mutations. Careful vigorous selection of the many hundreds of mutations was made. This planting and further selection continued until the new creation was

considered worthy of being designated a new variety."

James G. Ross, who joined the Agronomy Department as a grass breeder in 1947, was a co-worker of Franzke for a decade and a half. In 1980 Ross wrote, "Cliff Franzke, who had been with the department since 1924, had an enviable reputation as a breeder in such diverse crops as corn, sorghum, and grasses. He was an excellent selectionist and could pick out types that would be adapted to conditions in the state with great acuity. He elected to retain sorghum as the crop that he would continue working with as funds became available for hiring other plant breeders.

"I remember with great pleasure the fall harvesting trip that I took with him shortly after starting my tenure in the Agronomy Department. He had a story about each part of the state through which we passed and drove the state car with his one arm better than 90% of people could with two. The beauty and diversity of the state made a never-to-be-forgotten impression on me and I was sold on the opportunities for crop improvement that were present both in the more humid croplands of the east and the beautiful grasslands of the west.

"As a plant breeder Cliff realized the necessity for variation and became interested in colchicine, an alkaloid derived from the autumn crocus, as a means of inducing changes in the sorghum breeding material. The results he obtained were not typical of the chromosome doubling effect that normally occurs after colchicine treatment. I was well aware of this because I had worked with colchicine on flax for the M.S. thesis.

"All of us used to shake our heads when we looked at his material in the field because it didn't appear to make sense. In the winter of 1950-51 it occurred to me that the true breeding nature of the progenies that he obtained after colchicine treatment could be the result of somatic chromosome reduction. This phenomenon appeared in one line he called Experimental 3 and not in other genetic materials. This started an extremely friendly association directed towards determining if the hypothesis was correct.

"We were fortunate in obtaining National Cancer Institute money to support graduate students and National Research Foundation funds to support a Research Associate. By means of irradiation using a C060 source installed in a basement room in the greenhouse complex, translocations were obtained which allowed identifying whether homozygosity had occurred after treatment.

With the help of many enthusiastic students and Dr. Mary Sanders we were able to show that without any doubt homozygosity was achieved after colchicine treatment. The acceptance of the results by other scientists was dampened because our results could not be duplicated. Unfortunately, when Cliff Franzke retired, it was found that even in our laboratory we could not duplicate the phenomenon. The idea was excellent and perhaps in the future Cliff's tremendous observational ability in demonstrating the peculiar results will yield fruit."

Cliff was a teacher, too. He taught the agronomy courses in the School of Agriculture for about a quarter of century. He wrote most of his teaching manuals including "Field Crops Production Lecture Manual"; "Field Crops Production Laboratory Manual"; as well as teaching guides "Forage Crops I-Silage, Hay, Pasture and Grasses"; "Forage Crops II-Legumes"; "Crop Judging and Identification"; "Seed and Plant Identification"; "Grain Grading"; and "Crop Judging." Many of his former students became prosperous farmers and ranchers. When traveling in the state one frequently met one of them who would ask about Professor Franzke.

Cliff was not academically well trained, by modern standards, in the science of plant breeding; but he had a green thumb and an eye unexcelled for detecting desirable plant characteristics.

He is remembered as a quiet, slow moving, tobacco chewing individual who was seldom in the office. He was always in the greenhouse or field evaluating plants. He didn't depend on numbers (yield, etc.) to tell him when he had an outstanding line.

Typically he took Rose with him to move the irrigation pipes on his sorghum plots after they had finished eating on a hot summer evening in 1958. Though he was not feeling well and had passed his 62nd birthday, he chose to do the work rather than ask any of his aides to work overtime. After returning home, he suffered his first heart attack.

He recuperated and came back to work. Though he did not fully recover, he was more productive than many. He continued to work after he reached his 65th birthday, the normal retirement age, in 1961. The sorghum variety SD 100 and the hybrids SD 502, SD 503 and SD 252F were released in 1961 and the variety Winner in 1964.

Before he retired in 1964, the South Dakota Crop Improvement Association invited him to give the main address at its annual meeting held in Gregory. The Association also presented him with an award for outstanding service to South Dakota Agriculture.

Though many groups attempted to honor him, he was not interested in such things. A typical response was the one he made when informed that the Governor would present him an award at State Fair for the development of 39-30-S sorghum. "I'm not going out there to be paraded with the award winning bulls" was his response.

His name did appear, however, in publications that listed famous people. It appeared in the *International Blue Book* along with those of President Dwight Eisenhower and Queen Elizabeth. The book published in three languages by Chauncey House of London, Paris and New York stated in part "Clifford James Franske. Born Bijou Hills, South Dakota April 27, 1896. Son of William and Anna Franzke. Education: South Dakota State College . . . Fields of interest, corn breeding 1924-1944; sorghum breeding since 1930; sunflower, castor beans and safflower breeding since 1946. Associate Professor of Agronomy and Associate Agronomist South Dakota State College. Published many articles on agricultural subjects. Member American Society of Agronomy, Veterans of Foreign Wars, Past Pres. Alpha Zeta, Mason, Presbyterian."

A similar resume appeared in the *Dictionary of International Biographies* in 1964-65 along with resumes for such people as the Shah of Iran.

Cliff and Rose retired in Florida, but he frequently returned for consultations. Then in 1977 they moved to Orange, Texas to be near Cliff, Jr.

His hobby was cabinet making. He used his ingenuity to rig up all sorts of jigs so he could do intricate work with various saws, joiners, and planes in his shop. He made a pea podder that was in great demand by his colleagues and other friends during the summer. It had a rotating wooden paddle inside a rotating drum faced with hardware cloth. Garden peas were put in the drum and shelled with the rotating paddle. When the drum was rotated the peas dropped through the hardware cloth into a container and the shucks stayed in the drum.

Faculty members are not eligible to receive an honorary degree from SDSU, but after retirement Cliff was nominated several times to receive that honor from his alma matter.

In 1981, Dr. R. A. Moore, who coordinated the efforts of the group that submitted Franzke's name for the honor, wrote:

"I can't think of anyone more deserving of this recognition than Cliff. His professional career spans 4 decades, 1924-1964. Even after his retirement he was active for several years in completing papers and returning as a con-

sultant in the sorghum breeding project. The citation for the honorary degree describes his achievements in plant breeding with grasses, legumes and corn and his work with soybeans.

"His most significant work was probably with sorghum. He successfully rebuilt the forage-sorghum plant so it could be safely grazed by livestock and he developed grain sorghums that would mature in the Northern Plains. He was responsible for the beginning of weed research in South Dakota.

"The citation also notes that he taught all of the Agronomy courses in the School of Agriculture at different times, coached the judging teams and for 40 years conducted the FFA Crops Judging Contest. He touched many lives with his contributions through his teaching. This may even be more monumental than the many varieties of crops he developed.

"Several of his co-workers assisted in the development of the credentials that accompanied the nomination. A few of their comments show the regard that they held for him: 'He served with faithfulness and genius.' 'He dedicated his life to the harnessing of nature.' 'Who could be more deserving than one whose contributions have had utility and will live on to serve future generations yet unborn.' 'South Dakota honors itself with what Cliff Franzke did.'

"He found time for hobbies and community service. He became an excellent craftsman in woodworking, but his hobby of landscaping resulted in some rather permanent monuments, including the landscaping around his church; around the municipal swimming pool, around the former Brookings Hospital, four city parks and the Brookings Armory Auditorium."

When the first draft of this profile as written Cliff and Rose were living in Texas. Cliff had suffered several heart attacks and strokes. His eyesight was failing, but his mind was keen.

When discussing his nomination for an honorary degree, it was stated: "To this date he has been OVERLOOKED. This writer certainly hopes that this situation can be corrected while Cliff can still appreciate it. His name has to rank among the top half dozen individuals for contributions to South Dakota agriculture."

On February 26, 1981 Cliff and Rose had enjoyed a ride to Houston and back when Cliff, Jr. took his wife to the airport. They retired as usual. However, when Rose awoke the next morning and reached over to caress him, she learned that he had slipped away in his sleep during the early morning hours of February 27, 1981.

His body was returned to Brookings for memorial services in the Masonic Temple and the Presbyterian Church. At the Masonic services on March 1, D. E. Kratochvil, who had been an office mate in Agricultural Hall said:

"It wasn't just in his chosen field in which he served those around him. His neighbors always appreciated the tremendous floral display and garden in his yard. His service on the Brookings Park Board for years helped Brookings have parks we all enjoy today.

"He loved to work with wood--handicrafting many items including furniture, cabinets, etc.--that was a joy to many. I can remember the pea sheller he made which many of us used to ease the drudgery of sitting and shelling one pea at a time.

"His generosity, his hospitality, and his willingness to help those around him made him a person that enriched the lives of those that were fortunate to know him--a person to know, respect and love."

Though he could not deliver it, Ray Moore wrote the eulogy for the church services on March 2. Among other things, he said:

"We had a chance to visit with Rose and Cliff, Jr. last Saturday evening. I had some news I wanted to share with them and they later asked me to share it with all of you at this time.

"On February 26 I learned that the Council of Deans at South Dakota State University had nominated Professor Emeritus Clifford Franzke for an honorary doctorate degree for the Spring 1981 commencement. The announcement was waiting only for the formal approval of the Board of Regents." This was especially significant in this centennial year for the University.

"Cliff Franzke is one of the all time greats of this University. He ranks with the Huttons, the Hansens and the Humes."

LEO F. PUHR

Leo Puhr, a student of J. G. Hutton, was born in 1902, completed a B.S. degree on June 9, 1925, and a M.S. degree on June 13, 1927. He may have obtained the first advanced degree granted in soils.

He was appointed Assistant Professor of Soils in 1927. Except for Ph.D. work, completed in 1940 at the University of Wisconsin, he spent his life teaching, counseling students, and conducting soils research.



He taught all the soils courses during the late 1930s and the early 1940s. He taught courses in geology, soil classification and genesis, soil conservation, soil fertility and management, laboratory methods, soils seminar and soil problems. Though additional staff members taught some of these courses, during the 1950s he continued to teach general

soils, a required course for all students in Agriculture, until his illness prevented it (Bul 508).

His statement "Unlike a mine, which is exhausted with time, the soil will last indefinitely if properly managed and cared for" was his watchword for a third of a century (Bul 508).

Though his research contributions were varied, he spent most of his life living up to that watchword. His major work was in the area of soil fertility which included studies on the effects of cropping on the rate of depletion of organic matter, nitrogen, and phosphorus, and the use of fertilizer on South Dakota soils (Bul 508).

During 1941 he established extensive crop rotation and soil research plots on the new Agronomy Farm and the Highmore and Eureka substations. These experiments were designed to cover virtually every area of soil management (Bul 508).

He worked to develop crop rotations that would maintain soil fertility and produce optimum crop yields. He studied the influence of tillage on crop production, the value of crop residue for conserving organic matter and nitrogen and the use of monocropping in a crop rotation (Bul 508).

For years he worked closely with other staff members in areas where chemical analysis of plants or soils was concerned. He and Franzke, for example, worked closely on the study of cyanide poisoning of livestock by sorghum and he aided in the development of a low-acid variety.

Puhr was a Fellow of the American Association for the Advancement of Science and

a member of the American Society of Agronomy, Soil Science Society of America, and Alpha Zeta, an Agricultural honorary (Bul 508).

After a lingering illness, Leo F. Puhr passed away in October 1962. He had served South Dakota State College, thousands of students and the people of South Dakota for 35 years.

In 1979 John Grafius, a colleague from 1941 until 1953, wrote, "Leo Puhr had a brilliant mind, a charming personality and added a bit of class to the younger (at that time) set. He was an excellent teacher and a first rate expert in soil fertility. At the time I first knew Leo, the soils of South Dakota were considered young. Commercial fertilizers were, it was thought, not needed. Leo started his work during his period and was part of the group which brought about great changes in soil management programs in the State."

W. W. Worzella, who was Head of Agronomy from 1943 to 1958, wrote in 1981:

"Leo Puhr was a dedicated soils teacher and researcher. He taught thousands of undergraduate students in various soils classes and supervised the training and theses for many graduate students.

"He conducted soils research in the laboratory, greenhouse and on many farms throughout the state. He possessed a very practical approach to his work and problem solving since he gained first hand information from his three privately owned farms. He contributed greatly to the early recommendations for crop rotations and fertilizer use in South Dakota.

"Though quiet and reserved, he was a team worker--quiet and dependable. His judgment was highly respected as he kept well informed through his own investigations, the scientific literature and attendance at professional meetings.

"He made valuable contributions to his students and to the farmers of South Dakota."

LAWRENCE O. FINE

Lawrence O. Fine came to the Agronomy Department to begin work on July 1, 1946. His first assignment was largely teaching soils courses. Students included a large group of newly returned World War II veterans.

Larry was born in May 1917 and reared on a livestock-grain farm in Benson County, N.D. After high school he and his older brother farmed in partnership for a few years, in-

cluding the drought-grasshopper period of the mid-1930s. He graduated with a degree in soils from North Dakota Agricultural College at Fargo in 1938. After working a summer on the SCS project at Park River, N.D., he entered graduate school and completed the Ph.D. in soil chemistry at the University of Wisconsin in 1941. Following graduation he worked for short periods with the U.S. Department of Interior and the SCS, and spent about 3 years in the U.S. Navy. He was a member of the Agronomy Department at the University of Arkansas when he decided to come to SDSC.



There is no doubt that the dynamic leadership of W. W. Worzella inspired his colleagues and evoked a deep and lasting consciousness of the potentials and needs of South Dakota agriculture. In the case of Larry, this resulted in a

request for some research activity shortly after his arrival at SDSC. He was given the responsibility of an agronomic program at the Range Field Station (Cottonwood) in 1947 and the irrigation (Agronomy) field program for the Experiment Station in 1948. Field experiments in Yankton, Union, Fall River, Spink, Perkins, Turner and Beadle Counties, and laboratory and greenhouse experiments were the consequences of this development. The irrigation program of the Agronomy Department was augmented by cooperation and financial assistance from the USDA and Fine was appointed jointly as an Agent of USDA from 1950 to 1958. He had two assistants, R. E. Campbell and H. M. Vance. This arrangement terminated when Fine became Head of the Agronomy Department in 1958, a position held until June 30, 1969.

Fine was appointed collaborator to the U.S. Salinity Laboratory at Riverside, CA in 1950, a position he held until 1960. In this capacity he biennially took part in a review of the research being done at the Salinity Laboratory and gained much first-hand knowledge of research techniques, progress and status of world-wide salinity and sodium-soil problems, water quality problems, and the management of salt-affected soils and low quality waters. He was invited to come to the Salinity Laboratory on a permanent basis, but declined. However, he did serve as the training officer for foreign nationals

in training in soil science at the Salinity Laboratory under the AID program during the summer of 1956. It was this exposure to salinity problems in agriculture that gave Fine the background needed for the teaching, guiding of graduate students, and research and extension type of activity in salt problems in agriculture which occupied practically all his time and energy for the past 25 years.

When Larry Fine succeeded Wally Worzella as Head of Agronomy, he inherited a group of demoralized agronomists, whose enthusiasm had been greatly reduced. And U. J. Norgaard had retired. Larry was on his own. Though he too was somewhat demoralized, he decided that "the show must go on". With his sincerity, dedication, industriousness and leadership ability he held the department together, maintained the established programs and inaugurated many new ones. The administrative duties for the largest department on campus left little time for research. Since scientific investigation was his first love, he resigned as Department Head in 1969.

He then became a part-time member of the Water Resources Institute where he was able to give advice on water quality to hundreds of farmers. When farmers submitted requests to the state for irrigation permits, Larry had the responsibility of deciding whether the quality of the water to be used was suitable for use on the land to be irrigated.

He also conducted long-time experiments near Redfield to determine how effective deep plowing was for the reclamation of sodic claypan soils.

Larry was dedicated to the protection of soil--from erosion, from application of poor quality irrigation water, from improper application and drainage of irrigation water and from the irrigation of salty soils. He instilled these concepts in the minds of hundreds of students, graduate and undergraduate, who took his courses in conservation, irrigation and soil chemistry.

Through his untiring efforts great studies have been made toward making the public aware of the salt problem in South Dakota agriculture. Though he is considering retirement in 1982, he continues to show unboundless energy in this effort. The fruits of his experimentation for reclamation of claypan soils are yet to come.

Because of the large number of students and farmers who have adopted his philosophy, his labor will continue to bear fruit long after he retires.

W. W. Worzella, who preceded Larry as Department Head wrote:

"L. O. Fine, a soil scientist and teacher, is an untiring and dedicated individual whose main objective is to investigate soil problems, find the solutions and make them available for students and farmers. His research on soil problems is conducted not only in the laboratory and greenhouses but also on field plots at the branch experiment stations and farmers fields throughout the state. He is an excellent teacher both at the undergraduate and graduate level as well as supervising thesis for students working towards advanced degrees. He is a member of several scientific societies (Soil Science of America, SCS, etc.) participating in their committees. Dr. Fine is regarded highly by his fellow scientists and his peers by being selected to serve on their committees, recommended as a candidate for National awards and invited as visiting professor (University of California-Davis). He made great contributions to the recommended practice for irrigation and soil fertility for South Dakota.

JAMES GEORGE ROSS



Jim Ross, as his friends and associates have known him, was born on a farm in a grain and mixed farming area near Elgin, in the south-western part of Manitoba, Canada, on March 12, 1916.

His interest in forage crops was stimulated through the forage, pasture and seed production enterprises that were

part of his father's farm program. The agronomic program of the Junior Seed Growers Club (now a part of the 4H program) introduced him to the potentials for increasing yields through adapted varieties produced by plant breeding. He spent 3 years working on the home farm after graduating from Elgin High School. During this time he was part of a 2-man team representing the province of Manitoba Junior Seed Growers Club at the Royal Winter Fair at Toronto, Ontario.

With this background, he enrolled at the University of Alberta at Edmonton where he worked in the Field Crops Department during his undergraduate and graduate years. He received the B.S. degree with first class

honors in 1941, and the University of Alberta research scholarship for M.S. study which was completed in 1942. With the support of a National Research Council Studentship, he continued graduate work at McGill University before joining the Royal Canadian Air Force.

After the war he spent some months as a research associate at the University of Alberta before resuming graduate study at the University of Wisconsin where he received the Ph.D. degree in 1947.

He came to South Dakota State University in September of that year and has been a member of the Agronomy Department, now the Plant Science Department, since that time. During his tenure at SDSU he spent one year at Lund University, Sweden, supported by a Guggenheim fellowship and 2 years as a visiting professor at Ataturk University, Turkey, as a part of the University of Nebraska AID program.

He published 162 papers including scientific journal articles, presented papers and wrote several Extension and Experiment Station bulletins and articles.

Earlier work involved loose smut of barley where he demonstrated a linear relationship between its occurrence and yield reduction, and he also indicated sources of resistance through the use of improved inoculation techniques. His work with induced tetraploid in flax included the first study of quality changes resulting from polyploidy induction. In addition to demonstrating the use of cytological techniques as an aid in studying variability in local flora, he participated in the discovery of polytene chromosomes of corn. Knowledge of proper usage and management of cultivated grasses in South Dakota was increased through publications describing experiments, and testing the performance of grass species and varieties.

While in graduate school at the University of Wisconsin, Ross became associated with M. Wayne Adams. They both came to SDSC in the spring of 1947 as forage breeding candidates and both were accepted. Both were excellent geneticists. Ross had expertise in cytology and cytogenetics, while Adams was more interested in mathematics and statistics.

They were perhaps the best young pair of forage crop breeders in the U.S. They shared an office for a decade, shared teaching responsibilities and had the same dreams. They visited with N. E. Hansen together, toured the state together and planned together. It wasn't until 1958 when Adams left that some people realized that Ross 'n Adams was more than one word. They became well acquainted with the state and dedicated themselves to the develop-

ment of forage varieties that fit special needs of South Dakota farmers. After Adams left, it was learned that Ross was not the junior member of the team.

His research was responsible for a vast increase in the number of acres seeded to tame grasses. Homesteader smooth brome grass, released in 1951, filled an early need for an adapted high yielding variety free from noxious weeds. Oahe intermediate wheatgrass combined high seed and forage yields. It was recognized as an outstanding variety throughout the Great Plains and Intermountain states. A seed production area in the south central part of the state provided sustained income from the export of this seed.

The warm-season grass, Summer switchgrass, was selected on the same basis and it demonstrated the value of a warm-season grass pasture.

Rebound smooth brome grass was designed also for pasture in the warm part of the summer when brome grass ordinarily becomes dormant. The variety Retain creeping foxtail, selected for its ability to retain its seed and not shatter like older varieties, was released in 1980. Cottonwood smooth brome grass was released to provide a variety adapted to Western South Dakota that would provide seed for regrassing areas that should never have been plowed.

The research in sorghum genetics and cytogenetics, in which he collaborated with Professor C. J. Franzke, was designed to explain the phenomenon of true breeding mutants observed after colchicine treatment. This had tremendous potential importance to plant breeding if the conditions for its appearance could be ascertained. Under the condition of the experiments, after many years of work, it was concluded that the hypothesis of somatic chromosome reduction was supported as an explanation for the true breeding nature of the colchicine induced mutants.

Unfortunately, after Professor Franzke retired, it was found impossible to produce the phenomenon. Though the applicability of these findings to plant breeding or to the behavior of chromosomes did not develop as was originally anticipated, these researches did stimulate the examination of the sexual reproduction of other grasses resulting in the discovery of apomixis in sorghum and other species. The cytogenetics of sorghum is more thoroughly understood because of their work. More recently, somatic chromosome reduction has been used in obtaining genome segregates from wide crosses obtained through tissue culture techniques.

Dr. Ross participated in pioneering the use of in vitro digestion methods in grass

breeding. The variety Rebound released from his program had in vitro digestibility that was superior to that of other varieties of smooth brome grass.

While at Ataturk University in eastern Turkey, he provided leadership in researches designed to increase yields of winter wheat and winter barley. As a result of this work the American variety, Lancer winter wheat, was released for use in Eastern Turkey. In a booklet entitled "Wheat Production in Eastern Anatolia," he summarized investigations in wheat research and gave estimates of possible new developments in dryland wheat production. This became the basis of the developmental work designed to raise wheat yields under dryland conditions in that country.

In the educational area he contributed towards establishing a laboratory in undergraduate forage crops shortly after coming to South Dakota. The exercises included familiarity with live and dried specimens and the construction and usage of simple keys. These ideas established greater awareness and knowledge of better forages and their management among the future county agents and soil conservationists. In the area of graduate teaching in cytology and cytogenetics he made use of novel teaching methods to more clearly demonstrate the scientific method and knowledge in this field.

At the time that the Ph.D. program was started, Dr. Ross pioneered with the first student. Standards of excellence and procedures were formed which were later codified by the Graduate Council of which he was an elected member. He was major advisor to 12 Ph.D. and 12 M.S. candidates, during his career, more than any other agronomist.

He worked closely with his graduate students and some of them became his best friends. George Holborn expressed the feeling of most of them. While taking his oral examinations for an M.S. degree, some members of the committee started to question him on topics with which he was not familiar and he became somewhat concerned. Dr. Ross, who had chaired many such meetings, calmly and quietly guided the questioning into the proper channels. After the examination was completed the 250-pound Holborn said, "I love that old man."

Many of the students were from foreign countries and unaccustomed to our ways. Jim and his wife, Frankie, whom he met in Edmonton, spent much time helping them become acclimated.

As chairman of the Genetics Committee, he gave leadership in establishing a sound graduate genetics teaching program.

On the national scene he served on a committee of the Crop Science Society of America for the standardization of crop names. A book is being prepared as a result of this work.

Present grass breeding research is directed towards increasing the ease of stand establishment of the tall warm-season grasses. Large-seeded selections show a much increased seedling vigor. Varieties having this character will be released in the near future and should greatly increase the use of these species for summer pasture.

Recognition of Dr. Ross's contributions were made nationally when he was made a Fellow of the American Society of Agronomy in 1972. He retired June 30, 1981.

FREDERICK C. WESTIN



Frederick C. Westin was born in Florence, Wisconsin, where he attended grade and high school. After graduation from the University of Wisconsin and naval duty during World War II, he became, in 1947, the State Agricultural Experiment Station leader in a newly revitalized soil survey program for South Dakota.

In that position he coordinated the soil mapping activities of a state staff of up to eight scientists as well as the soil surveyors of the Soil Conservation Service, Forest Service, Bureau of Indian Affairs, Bureau of Land Management, and Bureau of Reclamation.

An early example of Dr. Westin's leadership was the annual Soil Survey Work Planning Conference at which the soil survey leaders of the above agencies were brought into an annual 2- to 3-day work conference. The program planning and the success of coordinating the mapping activities were largely the objective and the accomplishments of Dr. Westin. The conferences are still held and are very productive in solving mutual problems.

Throughout the early years of this renewed effort in soil survey activity, Dr. Westin pressed for the use of the standard survey in every possible situation, maintaining the greater utility of that as compared with other types of land inventory.

Soon after the revitalized survey program began, Dr. Westin's abilities were recognized in surrounding states, then nationally, then internationally. These activities began with correlation of soils along the borders of the state with Iowa, Nebraska, and North Dakota, and later, Wyoming.

Along with the excellent program in field classification and soil mapping, Dr. Westin initiated a thorough and basic laboratory effort in the chemical and mineralogical characterization of the major soils representing broad areas of the state. These laboratory phases resulted in vastly improved understanding of the genesis of the soils recognized in the field, and in many practical applications of the fertility and management implications of the soil chemistry.

For his work with the soil survey program Dr. Westin was awarded a certificate of appreciation by the Soil Conservation Service of the USDA.

A natural outgrowth of the field and laboratory programs was the application of soil geography information in many aspects of life. Dr. Westin's first interests in this area were those of crop adaptability, fertility and management requirements and productivity ratings of various soils. He provided invaluable assistance to soil management research workers, Extension specialists, County Extension Agents, industry conferences and individuals throughout his 34-year tenure of service in the Agronomy and Plant Science Departments.

An example of his facility in this area is his lead-off keynote address to the annual farm and ranch entrepreneurs brought to SDSC for a 3-day "Conservation Short Course" each year. These farmers and ranchers are the annual achievement winners of the conservation contests in the state's 70 conservation districts.

Another example of the usefulness of his work is the fact that he has been a consultant to the South Dakota Department of Revenue since 1967 on matters of land evaluation. In September 1978 he and Dr. D. D. Malo co-authored a South Dakota Agriculture Experiment Station bulletin, "Rating South Dakota Soils According to Productivity," in which the more than 500 soils of the state were rated for adapted crops.

Dr. Westin did soil consulting work in Venezuela, Mexico, Botswana and Kenya. Each of these work experiences exposed him to new problems requiring solutions which enriched the research program in South Dakota as well as provided new insights to scientists in those countries.

Besides national and international recognition of his ability in soil classification, soil genesis, land use interpretation and crop production guides, Dr. Westin earned major international recognition of his outstanding work in the use of remotely sensed imagery in making and using soil maps. His membership on a 6-man team to work with the Soviet Union on this theme is one illustration of his recognition and ability in the area; his consultantship position on the Large Area Crop Inventory Experiment (LACIE) team is another. For his work in the LACIE project he was awarded an achievement award by the National Aeronautics and Space Administration.

Dr. Westin's teaching ability and outstanding effectiveness as a lecturer has long been recognized. He has been in demand by many groups for his lectures on "The South Dakota Environment," "Soils of South Dakota," and other subjects.

In 1975 he was selected by students for the award "Teacher of the Year" in the College of Agriculture and Biological Sciences. In 1979 he was awarded the Gamma Sigma Delta Teaching Award of Excellence.

Dr. Westin's graduate students have without exception been inspired by his zeal, his keen and perceptive analyses of problems and his intellectual integrity. He has been an outstanding staff member and is recognized by the Dean, the Department Head, and other administrators for his incisive analyses of technical and administrative problems and skill in teaching matters. He served as chairman of the departmental curriculum committee and the representative to the college curriculum committee for a number of years.

Dr. Westin willingly extended his areas of activity to local, state, national, and international areas. Without hesitation, he met with organizations, leaders and individuals to organize symposia, devise procedures and actually take part and assist in the implementation of agronomic technology resulting from science in which he either had a part in developing or that became a part of his concern through association. The quality of this concern is witnessed by the increased scope of his participation, including international symposia such as the one at Konstanz, Germany (COSPAR), in 1973.

During two periods (August 1966-February 1967 and June-October 1978) Dr. Westin cheerfully and competently assumed administrative duties as Acting Head of the Department of Agronomy, and then Acting Head, Department of Plant Science, respectively. Although administrative work was not his first choice, he very effectively performed those duties and maintained his other activities.

Dr. Westin served the profession of Agronomy by serving as an associate editor of the Soil Science Society of America Journal from January 1975 to December 1977. He was chairman of Division S-5 and in 1979 was elected to the board of directors of the American Society of Agronomy. He is a member of the American Registry of Certified Professionals in Agronomy, Crops and Soils (ARCPACS).

Dr. Westin served as chairman of NCR-3, the North Central States Regional Research Committee on Soil Survey Activities, and was a member of the midwest and national committees for making changes in soil taxonomy. In these, as in all positions he held, he strove for the highest objectives of the societies--that of professional excellence.

His very effective work in soil survey interpretation and soil ratings for crop production, engineering applications, rural home construction, taxation and other uses was the earliest. His internationally recognized advances and skills in the use of remotely sensed imagery for soil geography studies is among the most recent of his contributions.

Dr. Westin was secretary of the SDSU Chapter of Phi Kappa Phi, and gave educational and instructive lectures to numerous civic and farm-oriented groups on soils and related natural phenomena. In these talks he weaved in parts of the science which he professed, and truly advanced the understanding and appreciation of Agronomy and soil science among the general public.

Dr. Westin was active in the formation of and continued growth of the professional Soil Classifiers Association of South Dakota, an active group of soil scientists across the entire state, whose primary purpose was the growth of professionalism within the ranks of soil surveyors and other soil scientists in the conservation districts of the state.

More than 50 publications on major phases of soil genesis, soil classification, soil geography, soil chemistry, the interpretation and use of soil survey information and data and the modern approaches to the use of remotely sensed imagery in soil mapping attest to the effectiveness of Dr. Westin's research.

In recognition of his work in soil science and agronomy, Dr. Westin was elected a Fellow in the Soil Science Society of America and a Fellow in the American Society of Agronomy in 1979.

On May 11, 1981 he left the Plant Science Department to join the Remote Sensing Institute. Though he retained a courtesy appointment in Plant Science, he will devote full time to his newest love, the use of remote sensing imagery.



D. Boyd Shank came to South Dakota as corn breeder in early October of 1946 after spending 5 years in Arkansas doing plant breeding work on both cotton and corn. The hot humid summers spent at a branch experiment station in the Mississippi Delta country and the wet, chilly winters at Fayetteville, Arkansas had convinced him that he would like to return to a part of the country

farther north. During his first week in South Dakota he found himself picking a corn yield test plot in a foot of snow near the town of Isabel. He finished harvesting that year the day after Thanksgiving in a plot near Elk Point, again in snow. He was about ready to return to Arkansas.

His early years prepared him to work on the limited budget of a small corn breeding program such as the one in South Dakota. He was born in 1914 on a farm in Jewell County, Kansas which, along with the neighboring town site now lies under the water of the man-made reservoir called Lake Lovewell. At 5 years of age he moved with his parents to a farm in northern Jewell County which is just across the Nebraska-Kansas state line from Superior, Nebraska. He attended a country grade school in Kansas and high school in Superior. During his high school years the depression of the late 1920s occurred. This was followed by the drought years of the 1930s and about half of his parent's neighbors lost their farms.

After high school he was persuaded to attend the Agricultural College of the University of Nebraska by a high school classmate which meant working his way entirely through college. He majored in Agronomy because of the influence of the Head of that Department, Dr. F. D. Keim. While at Nebraska he was a member of the crops judging team which won top honors at both the American Royal and the International Crop shows. He also became a member of the honorary agricultural scholastic fraternities, Alpha Zeta and Gamma Sigma Delta. He earned his Doctor of Philosophy degree in plant genetics at Iowa State University under Dr. E. W. Lindstrom.

There he became a member of the scientific society of Sigma Xi.

The South Dakota corn work in the late 1940s consisted of two projects, namely, testing commercial varieties and hybrids and, secondly, the corn breeding work. During the 1940s many open-pollinated varieties were still grown in the state and the hybrids were not well adapted for South Dakota conditions. As a result, variety testing was an important project because it guided farmers in selecting corn that was best adapted for their part of the state. Variety tests were conducted throughout South Dakota. With the results published in circular form. Shank continued this work until J. J. Bonnemenn took over the responsibilities in 1961.

Upon his arrival in South Dakota, the Department Head, Dr. Worzella, indicated that the breeding work should be directed toward developing inbred lines and their use in superior hybrids adapted to South Dakota environments. Not much existed in the breeding plots that first summer, which was 1947. In all there were only about 200 individual plots, and many of them were planted to inbred lines from other states. Not only were current hybrids low yielding but most were too late in maturity. Soft corn existed almost every year because the hybrids or varieties used did not mature before frost. In addition, the corn stalks often lodged because of their susceptibility to disease. Most corn also had little heat- and drought-tolerance. Thus, there were many problems which needed plant breeding efforts. The next 34 years were spent attempting to solve some of those problems.

Early efforts were directed toward the development of new inbred lines from the adapted open-pollinated varieties which were still being grown in the state and the search for desirable hybrids using inbred lines obtained from Franzke's early work at South Dakota and the better inbreds obtained from other states. Some of the early problems worked on were: the ability to mature in South Dakota's short growing season, the ability to emerge in cold wet soils, and heat and drought-tolerance. Later, in cooperation with Dr. C. M. Nagel of the Plant Pathology Department, stalk and root rot problems along with stalk strength and lodging resistance were undertaken.

Another phase of the work was teaching. Many graduates, as well as under-graduate students, were influenced by Dr. Shank. Work in the corn plots in the summer, an under-graduate plant breeding course, and graduate thesis problems eventually influenced many students to spend their life working on corn for either commercial companies or in experi-

ment stations. Several publications resulted from graduate thesis research efforts.

While Dr. Shank was at SDSU, the state average corn yield rose from 27 bushels in the 1940s to 74 bushels per acre in 1979. He contributed to this growth in several ways.

The dozen hybrids released during his tenure were bred for South Dakota conditions and improved the yield on thousands of acres. Many of the 17 inbred lines released were used by commercial corn seed companies to develop hybrids adapted to South Dakota. Thousands of acres were planted to these hybrids and produced higher yields.

Just as important is the fact that Dr. Shank trained several graduate students who became corn breeders. They learned his philosophy and produced many hybrids suitable for use in South Dakota.

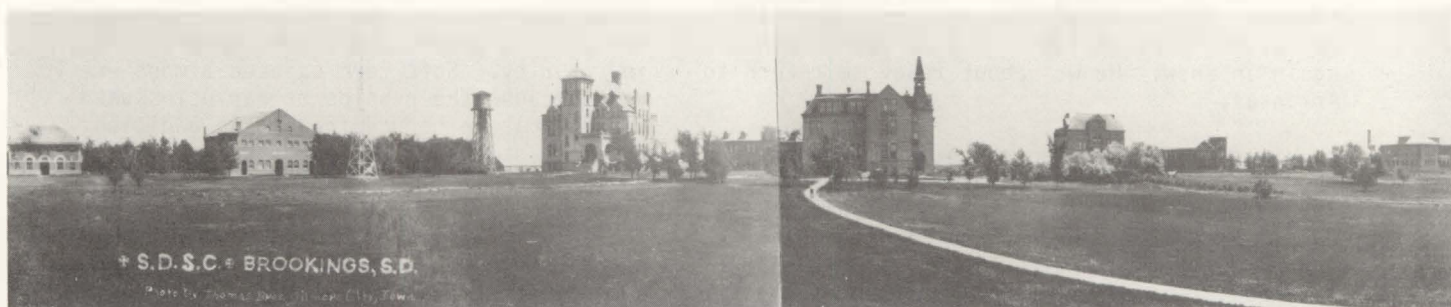
Dr. Donald E. Kratochvil, for example, became the corn breeder for Sokota Hybrid Producers in 1961. After 10 years, all the hybrids sold by the company had been developed by him. They

improved corn yields on a half million acres.

Dr. Stanley D. Jensen has been a corn breeder for Pioneer Seed Company for over a quarter century. He became project manager for the area including South Dakota. Under his supervision many high yielding hybrids, adapted to South Dakota conditions, were developed and sold to thousands of farmers in the state.

Dr. David Peters was employed by NC⁺ while Michael Koopman became a corn breeder for Golden Harvest--both companies selling corn in South Dakota. Dr. Neil Widstrom is breeding corn for insect resistance at the Federal Southern Grain Insects Research Laboratory and Dr. Rodney Hexem taught Agronomy for many years at Arkansas State College, Jonesboro, Arkansas.

Darold Termunde became a commercial corn breeder and developed suitable corn for South Dakota for several years. Glen E. Nachtigal was a part-time corn breeder for Sokota during the 1950s while serving as assistant manager; he became manager of the cooperative in 1978. All followed the Shank philosophy and used some of the inbred lines developed at SDSU.



Agricultural Building (1899), Armory-Gymnasium (1899), North (1887), Chemistry (1897), Central (1884), South (1883), Horticulture (1901), and Physics-Engineering (1901). (Photo taken between 1906 and 1912).



Agricultural Building, Armory-Gymnasium, North, Chemistry, Central, South, Horticulture, Physics-Engineering (1901). (Photo from Wenona between 1909 and 1912).

CHAPTER VIII DAKOTA AND BROOKINGS

Most activities in the department have been affected by the environment of the state, city, Land Grant College, Agricultural Experiment Station, Cooperative Extension Service and Agriculture Division; therefore, a brief history of each is given.

SUNSHINE STATE

The 77,041 square miles occupied by the state of South Dakota became a part of the United States in 1803.

Mound builders resided in the area prior to 1200 and the Arikara, or Ree Indians, figured prominently in the early history. During the sixteenth century the Arikara moved from the south into what is now the central part of the state. They were a non-nomadic people and were agriculturists. They bartered their surplus corn for skin, buffalo robes and meat, and were intermediaries in introducing the horse into the area. Horses became a significant item of barter in the Arikara's trade with the Teton Sioux.

French Rule

Prior to 1762 the area was part of the French empire in North America. During this period Pierre Gaultier de Varennes, the Sieur de La Verendrye, who opened a trading post near the present site of Kenora on the Lake of the Woods in 1727, was interested in searching for the "western sea." After moving his base of operations to Lake Winnipeg, he set out in 1738 to locate the sea and traveled as far as Mandan.

La Verendrye was killed by Indians sometime later. In 1742 Francois and Luis-Joseph La Verendrye, who had accompanied their father on the 1738 expedition, set out to explore the Northern Great Plains for a route to the sea. They entered Northwestern South Dakota in 1742 and may have sighted the Black Hills on New Year's Day of 1743. They placed the Verendrye lead plate on a hill west of the present sight of the city of Fort Pierre on March 30, 1743, before returning to their base.

Though most historians credit the Verendrye brothers as the first white men to visit South Dakota, it is probable that a party of the Duhut expedition, led by Daniel Greysalon, the Sier Duhut, may have visited the lake region during the summer of 1679.

Spanish Rule

In 1762, following the French and Indian War, French possessions west of the Mississippi

River were ceded to Spain. Under Spanish rule, fur traders began to visit the area. Their arrival coincided with that of the Sioux Indians pushing westward from the woodlands of Minnesota.

The Sioux, or Dakota as they called themselves, had three major divisions--Santee, Yankton and Teton. Sub-tribes of the Santees were Sisseton, Wahpeton, Wakpekute and Mdewakanton; subtribes of the Yankton were Yankton, Yanktonais and Assinoboin; and the sub-tribes of the Teton included the Brule, Two Kettle, Sans Arc, Blackfeet, Hunkpapa and Oglala.

About 1750 the Teton Sioux reached the Missouri River and in 1755 the Oglala Teton discovered the Black Hills. They drove the Arikara farther north. The southernmost Arikara village was near the mouth of the Grand River when Lewis and Clark passed through South Dakota in 1804.

Louisiana Purchase

Under Napoleon, France reclaimed Louisiana in 1798. Three years later it was sold to the United States for \$11,250,000. The Mississippi River formed the eastern boundary while the southwestern border coincided with the present east and north borders of Texas. This border extended from the mouth of the Sabine River on the Gulf of Mexico north and west to the northeast corner of the Panhandle. From there the border extended north to the Arkansas River near the present site of Dodge City, Kansas, and then west to the river's source in Southeastern Colorado.

The northern border was determined in an Anglo-American convention. In 1818 the 49th parallel between the Lake of the Woods and the Rocky Mountains was established as the American-Canadian border. The new territory comprised 828,000 square miles and cost less than three cents per acre.

The Lewis and Clark Expedition, a party of 45 men that left St. Louis on May 14, 1804, followed the Missouri River and passed the mouth of the Sioux River on August 22, 1804. The group made camp on the South Dakota side of the river near the present town of Elk Point. A day or two earlier, Sergeant Floyd, one of two who died on the trip, had died and was buried on a bluff near the present town of Sergeant Bluffs not far from the mouth of the Floyd River. The expedition reached the Pacific Ocean on November 15, 1805. It retraced its steps and entered South Dakota in mid-August 1806. Lewis died in 1809 at the age of 35.

Territorial Days

In 1849 the area east of the Missouri River became part of the Minnesota Territory. Five years later the west river area became part of the Nebraska Territory which also included Nebraska, most of Wyoming and the eastern three-fourths of Montana.

In July 1851, in the Treaty of Traverse de Sioux, the Santee Sioux ceded most of the lands east of the Big Sioux River to the United States government.

In 1855 Captain John B. S. Todd, who had been stationed at Fort Pierre, left the army to join D. M. Frost, who had resigned his army commission in 1853, to engage in Indian trade. They operated a series of trading posts from their headquarters in Sioux City. Todd took charge of the posts in the Yankton area.

During the summer of 1856, representatives of Western Town Company from Dubuque, Iowa, attempted to stake a townsite claim of 320 acres at the falls of the Sioux River. The two agents were driven away by unfriendly Indians. A larger party returned the next May, occupied the townsite and named it Sioux Falls. One month later the Dakota Land Company of St. Paul occupied an adjacent 320-acre townsite and named it Sioux Falls City.

Enroute to Sioux Falls the Dakota Land Company located townsites at Flandreau and Medary. The latter was named for the Governor of the Minnesota Territory, an active member of the Dakota Land Company. However, the Yanktonnais Sioux refused to honor the Treaty of Traverse de Sioux and forced the settlers to leave.

In the Yankton Treaty of 1858, the Yankton Sioux ceded the land between the Sioux and Missouri Rivers as far north as Ft. Pierre and Lake Kampeska. Shortly afterwards townsites were established at Yankton (1859), Vermillion and Bon Homme.

Minnesota became the 32nd state in 1858. Inhabitants of the portion of the Minnesota Territory not included in the new state made several attempts to get the federal government to organize a new territory. J. B. S. Todd, who had political connections in Washington, D.C., made several trips to the capital. In 1861 he presented petitions and successfully lobbied for the organization of Dakota Territory.

On March 2, 1861, President Buchanan signed the Organic Act which combined the remainder of the Minnesota Territory and the northern part of the Nebraska Territory into the Dakota

Territory. It included the area now occupied by North and South Dakota, most of Wyoming and that portion of Montana east of the Rocky Mountains.

In March 1862, President Lincoln appointed Dr. William Jayne, a close friend from Springfield, Illinois, as the governor of the Dakota Territory. Yankton was selected as the capital. It so happened that Todd, who lived at Yankton, was a former resident of Springfield, an acquaintance of Jayne and a cousin of Mrs. Abraham Lincoln.

The first territorial legislature convened March 17, 1862. After considerable political maneuvering, Yankton was selected for the permanent capital, Vermillion for the territorial university and Bon Homme for the penitentiary.

Yankton, however, was located in the extreme southeast corner of the territory. Most legislators lived nearby and the remainder of the territory was poorly represented.

A year later, Western South Dakota, most of Wyoming, and Eastern Montana were merged with the remnants of the Oregon Territory. Washington, Idaho and Western Montana, which became part of the Oregon Territory in 1848, were orphaned in 1859 when Oregon became the 33rd state.

The discovery of gold caused an influx of 14,000 prospectors at Florence, Montana in 1861. Important new discoveries a year later expanded the mining region by hundreds of miles and thousands of men.

On March 4, 1863, the Idaho Territory was created to include all the new mines in what is now Western South Dakota, Montana, Idaho, most of Wyoming and Eastern Washington. Delegates from the northern Black Hills attended the first Idaho Territorial Legislative Assembly in Moscow.

Lewistown was selected as the capital but it was a long way from parts of Montana that were overrun with thieving road agents. The Montana Territory was established May 26, 1864, and the Wyoming Territory was created on July 25, 1868. The two territories included the areas that later became states with the same names.

At that time the mining area of South Dakota once again became a part of the Dakota Territory which then included North and South Dakota. The Legislative Assembly of 1885 voted to move the territorial capital to Bismarck.

Statehood

Six states from these territories were admitted to statehood in a 10-month period. The

Dakota Territory was divided along the 7th standard parallel on November 2, 1889. Papers admitting the two states to the union were shuffled before being signed by President Harrison. Though no one knew which papers were signed first, it has been generally stated that North Dakota was the 39th state and South Dakota the 40th. Montana became the 41st state on November 8, Washington the 42nd on November 11, Idaho the 43rd on July 3, 1890 and Wyoming the 44th on July 10, 1890.

State Name

The First Constitutional Convention met at Sioux Falls in 1883 to consider the division of the Dakota Territory and the selection of a name for the proposed new state. It was proposed that the territory be divided along the 46° parallel, but the name of the new state was not determined. It appeared that Dakota, South Dakota, Lincoln, Garfield or any other good name would be acceptable.

However, later there was widespread feeling against any change in the name Dakota, even to adding "North" and "South." Both sections of the territory wanted the name. Most of Southern Dakota and many influential citizens of the other faction believed that Northern Dakota should take the name Pembina--the Chippewa name for the highbush cranberry prevalent in the northern Red River Valley. Before Dakota Territory was organized, the whole section of the Northwest had been known as "The Pembina Country."

The final selection of a name for the new state hinged upon the fight over whether to admit Dakota Territory as one state or two, and if two, whether they should both be admitted at the same time. If the territory had been admitted as one state, the name of course would have been "Dakota," and if the southern half had been admitted first it appears that it would still have been "Dakota."

In 1884 the Harrison Bill provided for the admission of the "State of Dakota" and the organization of the northern section as Lincoln Territory. In 1885, however, a committee was appointed at the Fargo convention to visit the Sioux Falls Constitutional Convention to persuade the southern delegation to change the name from "Dakota" to "South Dakota." Those at the Sioux Falls meeting adopted a resolution stating that the name "Dakota" should not be allowed to endanger acceptance of the constitution, and that "South Dakota" would be substituted if necessary.

In 1887 conventions at Huron and Fargo both adopted resolutions urging that the name be changed to permit the use of "South" and

"North" Dakota. Congress, in the Enabling Act of 1889, authorized the people of Southern Dakota to vote once more on the 1885 constitution and, if it was accepted, to change the name from "State of Dakota" to "South Dakota." This was quickly done and the new state was named.

The word Dakota is what the Sioux Indians called themselves and has been interpreted as "friendly people" or "alliance of friends." Because of dialectic differences among the sub-tribes the name "Dakota" is also pronounced as "Lakota" or "Nakota."

Population

During its first decade, fewer than 12,000 people migrated to Dakota Territory, establishing settlements largely along the Missouri, Big Sioux, Vermillion and James Rivers, and in the Red River Valley.

Rate of settlement increased, however, with the completion of roads and railroads. The rumors of gold in the Black Hills following Custer's 1874 expedition also hastened development.

Shortly after the Dakota Territory was created, W. W. Brookings of Yankton, supervised the construction of a wagon road from Pipestone through Forestburg and Wessington Springs to Fort Thompson. Today S.D. Highway 34 follows a similar route.

Another road between Sioux City and Fort Randall was completed in 1865. Major projects on this route were the construction of bridges across the Sioux, Vermillion and James Rivers--the latter being near Yankton.

The construction of a highway network was initiated during the 1920s, and five bridges--one each at Mobridge, Cheyenne Crossing, Pierre, Chamberlain, and Wheeler Crossing--were built across the Missouri River from 1924 to 1926. The Dakota Southern Railroad, extending from Sioux City through Elk Point and Vermillion to Yankton, was opened in February 1873. Railroads were completed to Sioux Falls and Watertown in 1878.

The Dakota Central reached Brookings on November 17, 1879, and pushed westward, reaching Pierre in 1881. Then there were nearly 4,000 miles of rail lines in the state. After the Missouri River was bridged in 1907, the Milwaukee and the Chicago and Northwestern both built connecting lines to the Black Hills.

With the coming of railroads came the rush for land. Prior to 1878, most of the population was located southeast of a line drawn

from the present towns of Brookings to Tripp. However, during the next decade the influx of people led to the settlement of most of the area east of the Missouri River. Total annual filings and final entries for land ranged from 1 to 5.4 million acres. The peak year was 1883, and the total was 24 million acres during the 10-year period.

The area which now forms South Dakota had 11,776 inhabitants in 1870, 348,600 in 1890, and 401,579 in 1900. It increased to 583,888 in 1910, 636,747 in 1920, 642,91 in 1940, 652,740 in 1950, 680,514 in 1960, 666,257 in 1970 and 670,178 in 1980.

LAND OF INFINITE VARIETY

Diversity is commonplace in many aspects of South Dakota--people, religion, topography, climate, soils, crops . . .

Physical Features

The Missouri River divides South Dakota into almost equal parts. The river channel, for the most part, is 300 to 500 feet below the bordering uplands with the river plain seldom more than two miles and sometimes less than one mile in width. Because of these features dams were built across it during the 1950s at Gavin's Point, Fort Randall, Oahe and Big Bend.

The Missouri River drains the entire state, except for a small area in the northeast which drains into the Red River of the North. The chief tributaries of the Missouri are: on the west, the Grand, Moreau, Cheyenne, Bad, and White; on the east, the James, which rises in North Dakota and is said to be the longest unnavigable river in the world, the Big Sioux, which flows along the eastern boundary, and the Vermillion.

The area was subjected to glaciation and is a gently rolling plain. Originally, it was treeless except for the narrow margin along the streams. It is marked by a low range of hills in the extreme northeast, known as the Coteau des Prairies, which is several hundred feet higher in elevation and therefore, somewhat cooler than the James Valley to the west and the Whetstone Valley to the east. Near the town of Summit is the highest point in Eastern South Dakota with an elevation of about 2,100 feet.

On the Coteau there are numerous glacial lakes such as Poinsett, Kampeska and Waubay. The lowest point in the state, at Big Stone Lake, is 965 feet. Oddly enough, this is a continental divide. From this point the water flows northward through the Red River of the North to the Hudson Bay, or south through the Missouri to the Gulf of Mexico.

The James River flows the entire length of the state from north to south and is flanked by the richest agricultural region in the state. The James Valley averages 60 miles in width and drops only 100 feet in elevation in its course from the North Dakota border to Yankton where it enters the Missouri.

The land west of the Missouri is largely rolling grassland cut by a number of streams of considerable size. Irregular plateaus are broken by barren sandstone buttes rising abruptly from the plain; among these are Thunder, Castle Rock, Bear, and Slim Buttes. South of the Belle Fourche River the land becomes rougher, rising to short ranges known as Cave Hills and Short Pine Hills, and culminating in the Black Hills. On either side of the White River are the Badlands, a 30 to 50-by 120-mile tract where eroded areas are interspersed with numerous grassy, flat-topped tablelands.

Elevation increases from 1,200 to 1,300 feet in the James Valley to between 4,000 and 5,000 feet in most of the Black Hills. This well-eroded group of mountains was so named because of the black-green growth of yellow pine which mantles the heights. The 60- by 125-mile area is virtually the only wooded section of the state and the source of a wide variety of minerals. Harney Peak with an elevation of 7,242 feet is the highest point east of the Rocky Mountains.

Climate

South Dakota, because of its inland position, has a continental climate with extremes in summer heat and winter cold. It is in the path of storms moving south and east, a position which results in daily temperature fluctuations. Temperatures during the winter months often drop to -20° or lower while summer temperatures are sometimes over 100°. Average annual temperature ranges from 48° in the south to 44° in the north and 42° on the Prairie Coteau of northeastern counties.

The 100th meridian, the usual dividing line between the humid and arid areas of the country, passes through the state near the towns of Selby, Onida, and Presho.

Average annual precipitation ranges from 24 to 25 inches in the southeast to less than 14 inches in the northwestern part of the state. Most precipitation is in spring and early summer. Fall, winter and spring moisture results from condensation of warm moist air from the Gulf of Mexico that overrides heavier polar air masses. Much summer rainfall comes in short hard showers. In eastern counties, June normally has the most thunderstorms, while they are more prevalent during July in western counties. Seasonal snowfall averages

between 30 and 50 inches, but the amounts vary widely in different parts of the state. The Black Hills, because of their height, have a cooler, moister climate than the rest of the state (Bul 656).

It is estimated that South Dakota receives less than 75% of its normal rainfall 20% of the time, but about 75% of the precipitation falls during periods best suited for plant growth. Severe droughts occurred in 1887-1894, 1910 and 1911, 1934 to 1936 and in 1976. Less severe droughts were experienced in 1914 and 1915, 1930 to 1933, in the mid-1950s and during 1980 and 1981.

The lines of equal temperature and equal precipitation cross roughly at right angles. Relatively speaking, this makes the southeast warm and moist, the northeast cool and moist, the southwest warm and dry and the northwest warm and very dry (Bul 656).

Soils

Originally the land surface of most of the state was composed of Pierre shale. Most streams flowed in an easterly direction. However, glacial ice entered the state from the northeast and north and flowed south and west. As the ice moved, it filled valleys, planed off hills, forced the cutting of new valleys, piled up large ridges and otherwise changed the pre-glacial topography (Bul 656). Rivers were diverted; they flowed around the western edge of the glacier and formed a south-flowing Missouri River.

Generally speaking, the state is divided into two types of parent materials, the "gumbo" of West River and the glacial till of East River. Exceptions include the Black Hills, Badlands and Sand Hills of West River; the windblown soils of Brookings, Moody, Minnehaha, Clay and Union counties; and the alluvium along stream beds that are most extensive in southern Clay County (Bul 656).

Soil development is an interaction of five factors: parent material, climate, vegetation, relief (topography) and time. The variations in parent material and topography had an effect on the type of vegetation, but climate had a greater effect. Vegetation, in turn, influenced the development of the soil.

Except for the Black Hills, which are timbered, and the river valleys, where trees and brush prevail, the native vegetation of South Dakota was originally grassland. Differences in climate resulted in differences in grassland (Bul 656).

East of the James River Valley tall grasses prevailed. West of the James, tall grasses

were found primarily on sandy soils and cool northern exposures, and medium and short grasses assumed dominancy. In Western South Dakota, shorter grasses largely replaced the mid-grasses because of decreased rainfall (Bul 656).

The native grasses determined the amount of organic matter in the soils. In general, the tall grasses left relatively large amounts of organic matter in the soils. Moving westward, grass size diminished and lower amounts of organic matter were left in the soil.

Temperatures also played an important part. In the cooler northern part of the state, more organic matter and total nitrogen were present than in southern areas with equal precipitation. This was due to slower biological decomposition and chemical activity under cooler temperatures (Bul 656). Nitrogen is an element used in large amounts for crop production.

Field Crops

Crop adaptation is governed by soil, climate and topography. From the standpoint of agronomic crops, South Dakota is a transition area. It is the western edge of the corn and soybean belts, the northern edge of the winter wheat and sorghum growing area, the southern edge of the hard red spring wheat belts and the eastern edge of the rangelands.

In addition, the two Dakotas and Minnesota are the center of production for durum wheat, flax, winter rye and sunflowers. South Dakota, Minnesota, Iowa and Wisconsin are the major oats producing states. Alfalfa and wild hay are major crops; a sizeable amount of alfalfa seed is produced; between 5,000 and 6,000 acres of potatoes are raised; and, prior to the drought of 1976, South Dakota produced more Kentucky bluegrass seed than any other state.

Each year South Dakota farmers normally plant about 3 1/2 million acres of corn, 2 to 2 1/4 million of oats, over 2 million of HRS wheat, almost 1 million of HRW wheat, about 1/2 million of both barley and flax, 400 to 500 thousand acres of sorghum, 350 to 400 thousand of soybeans, 200 to 400 thousand of winter rye and 150 to 200 thousand of durum wheat.

They also harvest about 2 1/2 million acres of alfalfa hay and around 2 million acres of native hay. Native hay is harvested from some of the 25 million acres of rangeland. The acreage of sunflowers, a relatively new crop in South Dakota, may stabilize at about 300,000 acres.

The greatest concentration of corn and soybeans are in the southeastern counties. Corn

is planted on over 30% of the acreage in Minnehaha, Lincoln, Union and Clay counties, and soybeans on 12 to 18% of the latter three counties. The remainder of the soybean acreage is east of a line drawn through Sisseton, Madison and Wagner. Corn acreage extends farther north and west. 20 to 30% of the acreage is east of a line through Brookings, Howard, Armour and Wagner and 6 to 12% of the acreage east of Aberdeen, Wessington Springs, Kimball and Gregory (Bul 656).

Oats is planted in every county with 5% or more of the acreage in each East River county, except for Buffalo, Hughes, Hyde, Hand and Spink. Its greatest concentration is similar to corn--over 10% of the acreage east of a line through Milbank, Watertown, Arlington, Mitchell, Armour and Wagner, except for Clay and Union counties, and 17 to 22% of the acreage in McCook, Lake, Hanson and Hutchinson (Bul 656).

Barley, too, is grown in every county. Most malting barley is raised east of the Missouri and north of U.S. Highway 212 with the greatest concentration (4 to 5%) in Brown, Day and Marshall counties and a lesser amount in adjacent counties. Feed barley is most common (2 to 3% of acreage) in Kingsbury, Lake, McCook, Miner, Jerauld, Aurora and Douglas counties, and less than 1% of the areas in West River counties and the half dozen corn and soybean counties in the extreme southeast (Bul 656).

Hard red spring wheat is also grown in every county; but most of it is raised in the northern half of the state. It is planted on 10 to 14% of the acreage in Spink, Brown, Walworth, Campbell, Sully and Marshall counties and on 7 to 9% of the acreage in the remaining area east of the Missouri and north of U.S. Highway 212. Large acreages are also planted in the West River counties of Corson and Perkins. Almost all of the durum wheat is produced in the northern two tiers of the East River counties with the greatest concentration (2 to 2.5% of acreage) being in Day, Codington and Edmunds counties (Bul 656).

Though winter wheat is grown in over 60 counties and sorghum in 45, the greatest concentrations of both crops are in the south central counties. From 5 to 8% of the acreages in Bennett, Jones, Lyman and Sully counties, and slightly less in Haakon, Jackson, Stanley, Hughes and Tripp are planted to winter wheat.

The greatest concentration of sorghum acreage is inside an area bounded by the towns of Mission, Presho, Wessington Springs, Forestburg, Spencer and Tyndall, with the greatest concentration being in eastern Charles Mix, Gregory, Douglas and Bon Homme counties (Bul 656).

Winter rye and flax are grown primarily in northeastern counties. Rye occupies 2 to 3.5% of the acreage in Faulk, Edmunds, Spink, Clark, Codington and Grant counties and 0.4 to 1.9% of the acreage in counties adjacent to them. Flax is adapted to the Prairie Coteau and is planted on 7 to 17% of the acreage in Hamlin, Codington, Day and Clark counties and on 4 to 6% of the area in adjacent counties to the northeast and south of them (Bul 656).

Alfalfa hay is produced in every county of the state. From 5 to 10% of the acreages of all East River counties, except Buffalo and Union, and all West River counties, except Todd, Tripp and Gregory are devoted to the crop. Likewise, small amounts of alfalfa seed are raised in every county, but the highest concentration of acreage is in the south central counties of Tripp and Gregory with lesser amounts in southwestern counties of Fall River, Jackson, Washabaugh and Bennett (Bul 656).

Native hay is also produced in every county, but the largest concentration of production is 8 to 10% of the areas of Central South Dakota in McPherson, Edmunds, Faulk, Potter, Hyde, Hand, Buffalo, Jerauld, Brule and Aurora counties. The concentration gradually decreases in each direction.

Though prairie hay is an important crop west of the river, a major portion of the area is used for grazing. From 80 to 93% of the areas of Buffalo and all West River counties except Lyman, Tripp and Gregory are occupied by rangeland. Over 60% of the latter two counties and those bordering the Missouri on the east are devoted to grazing. The concentration is between 50 and 60% in all other East River counties except Brown County, the Whetstone Valley in the northeast, and the area in Southeastern South Dakota east of a line from Brookings to Lake Andes. East of this line the percentage of acres devoted to range or pasture drops to between 35 and 45% (Bul 656).

Sunflowers are grown primarily in northeastern counties, but as acreage increased, more were planted in north central counties. Almost all of the potatoes are raised in Clark and Codington counties.

BROOKINGS

Brookings County was created on April 5, 1862, by an act of the Dakota Territorial Legislative Assembly. The county was about 45 miles from east to west and almost 40 miles from north to south. It encompassed the northern half of what is now Moody (including Flandreau) and Lake counties and the eastern two tiers of townships in Kingsbury County.

Brookings County was bordered on the north and south by Deuel and Minnehaha counties.

Brookings was named for Judge Wilmot W. Brookings of Minnehaha County, who was a prominent settler in Dakota. He studied law at Bowdoin College and was admitted to the bar in 1857. He came to Sioux Falls in August of that year and was given charge of the townsite that had been created by the Western Town Company in May. At that time Sioux Falls had a population of 16--10 representing the Western Town Company and six, the Dakota Land Company.

Early in February 1858, while on a trip for his company, he fell from his horse into Split Rock Creek at about seven o'clock with the temperatures near 30° below zero. He struggled all night and reached Sioux Falls the next morning. Both legs were frozen and had to be amputated below the knees. It was done by a young doctor with a butcher knife and small saw.

Even after this he took an active part in the development of Dakota Territory. He moved to Yankton, perhaps in 1862 when a Santee uprising forced all the settlers to leave the Sioux Valley. He preempted the first land obtained from the government in the Dakota Territory on October 18, 1862.

From 1862 to 1869 he served 4 years in the Council and 3 in the House of the Territorial Legislature and was elected presiding officer of each. He also supervised the construction of the wagon road from Pipestone to Fort Thompson and served as prosecuting attorney for Yankton County.

He served as associate justice of the Territorial Supreme Court from 1869 to 1873. At the same time, he took a leading part in promoting the Southern Dakota Railway, the first line built in the territory. The first locomotive on the line from Sioux City to Yankton was named "Judge Brookings."

There were no white inhabitants in Brookings County when it was first created. In the spring of 1857, representatives of the Dakota Land Company at St. Paul came up the Minnesota River to New Ulm, Minnesota, and then by ox team to the site of Medary on the Sioux River. They located a town and named it for Governor Medary of the Minnesota Territory, intending to make it the capital of the new territory that would be formed after Minnesota became a state.

The group then followed the Sioux River, located the townsite of Flandreau, and arrived in Sioux Falls in June only to find that the best site was already occupied by the Western Town Company.

Major F. J. DeWitt and a party of 14 men returned to Medary, built quarters and remained during the winter. However, in June of 1858 they were given a few hours by a band of Yanktonnais Sioux to pack enough provisions to last them to the nearest settlement. The settlers left without bloodshed. It was about 11 years before other settlers arrived.

The first permanent settlement in Brookings County was started on the east banks of the Sioux River, 4 miles northwest of Medary (Sec 9, T 109N, R 50W). The settlement was made by Nils O. Trygstad and his five sons. They were followed shortly by two other families and in 1871 by ten more families. In the fall of 1871 the Medary post office was established on Sec 9, T 109N, R 50W, with Martin N. Trygstad as postmaster.

On January 13, 1871, a 3-man commission was appointed to organize a county. During 1872 and part of 1873, the county seat was in the home of W. H. Packard on Sec 26, T 109N, R 50W. During 1873 the town of Medary was plotted on the SE $\frac{1}{4}$ of Sec 26, T 109N, R 50R. It was near the center of Brookings County and named as the county seat. However, during the same year the boundaries of the county were changed by setting off two tiers of townships in the south. It is probable that two tiers of townships were set off on the west at the same time, forming the present boundaries.

In 1873 five families entered land on a Medary Creek in Trenton Township. The next year the first wheat grown in the county was raised on a 5-acre field near Medary by E. C. Cook. It was harvested with scythes and threshed by having oxen walk on it.

Two families settled at Oakwood Lakes in 1870. They were followed by two other families in 1873 and by 1877 there were seven families living near the lakes. The town of Oakwood was plotted in 1878. During the same year the town of Fountain sprang into existence.

The center of the county was filling up fast. During the 9-year period from 1869 to 1877, the population figures for the county were 14, 30, 52, 66, 140, 180, 150, 200 and 250.

During the decade 1875 to 1885 the population doubled, partly because of railroad development. The Northwestern Railroad had planned to build a line through Medary, but changed its plans and projected three towns at Elkton, Aurora and one on the Sioux River. The latter site was deemed impractical and was moved to the present site of Volga. The Dakota Central Railroad extended across the county in 1879 and 1880. The Watertown branch was built as far as Castlewood in 1881 and completed in 1883.

Bruce was established on it in 1881. The Burlington, Cedar Rapids and Northern Railroad crossed the eastern portion of the county in 1884. White and Bushnell were established along the line in that year.

City of Brookings

In 1879 several residents, mostly from Fountain, contacted officials and asked that a townsite be located near the present location of Hillcrest Park and Elementary School. The railroad officials maintained that it would be too difficult for trains to climb the hill, but agreed to locate a depot at a lower elevation about a mile to the southwest. That location not only made it easier for the trains but it was a little further from Aurora. Railroad officials had promised that there would not be a town between Aurora and the Sioux River.

Some enterprising citizens purchased the relinquishments of a claim to a portion of Sec 6, T 110N, R 50W and donated it to the Northwestern Railroad for townsite purposes. They secured a station and a portion of the town of Brookings was laid out in October 1879.

The original plot of the town was made on October 3 and 4. It included five blocks on what is now Main Avenue and the triangular piece north of the depot between what are now Front and Third Streets.

The site was selected because it was near the center of Brookings County and with the idea that the town would become the county seat. There was a rush to the new town. Medary was moved almost bodily to Brookings. Much of Fountain also moved to Brookings but some of it was moved to Aurora.

On November 4, 1879, the question of moving the county seat from Medary was submitted to the voters. Brookings, Aurora and Volga were in contention and Brookings won--county records were transferred to Brookings near the end of the year.

The Dakota Central branch of the Northwestern Railroad reached Brookings on November 17, 1879; the first load of lumber arrived soon after, and the town began to grow.

The city council urged that shade and ornamental trees be planted along the streets. The citizens responded and during the spring

of 1881 trees were planted that provided shade and beauty for the golden anniversary celebration and many years longer.

The city was incorporated under a special act of the legislature in April 1881. By 1886 it had a population of 1,200.

The population soon doubled, and by 1900 there were 2,346 residents. This number grew to 3,924 in 1920, 7,764 in 1940, 10,558 in 1960, 13,717 in 1970 and 14,956 in 1980.

Residents of Brookings were always interested in the College. In August 1881, they raised \$600 to purchase the 80 acres on which the campus was built. Three years later they raised \$1,000 to dispose of the bonds that the territorial treasurer was attempting to sell in order to build Central, the first building. A group of townspeople bought Woodbine Cottage in 1896 for the college to use. It has been the president's home since 1903.

The State College Development Association, a group of Brookings residents, paid \$12,800 on May 10, 1929, for the Olson Eighty on which the Plant Pathology Farm has been located for many years. On March 1, 1950, the same group paid \$40,500 for the 320-acre Larson Farm which was rented by the college for the production of livestock feed. Rent eventually paid the purchase price and interest, and the college obtained title to it on March 12, 1963. The USDA Northern Grain Insects Research Laboratory was built on it in 1961 and the poultry unit in 1968.

During the 1950s the State College Development Association built Development Hall near the corner of 14th Avenue and 9th Street. It was used as a dormitory for several years then as an office building. It was destroyed by fire in 1969. Insurance obtained by the association was used to build the new Horticulture Field House near the curve of U.S. Highway 14 bypass in 1970.

Many college faculty and townsmen comingle on the city commission, other city boards, the school board, and in churches and many civic organizations. The presidency of some civic organizations is traditionally alternated between a faculty member and a townsman.

Brookings has been good to the college and the college, in turn, has been good for Brookings.

CHAPTER IX THE LAND GRANT COLLEGE

The Land Grant College of South Dakota was erroneously called an agricultural college for a quarter century. It has had five names and fourteen presidents. Most name changes denoted a broadening of its programs.

Details of the origin, development, turmoils and growth of the Land Grant College are given in three histories. The first was edited by William H. Powers in 1931, the second compiled by Charles L. Sewrey in 1959 and the third was written by J. Howard Kramer in 1975. Since each history quoted the previous, this writer did not review the first writing. A fourth report entitled "Seventeen Years" covered the period from 1958 to 1975 when Dr. H. M. Briggs was president.

This chapter is composed almost entirely of quotations from Sewrey, Kramer and "Seventeen Years." The source of information is simply indicated by using "S", "K" or "17 yrs" with appropriate page numbers.

CHANGE OF PHILOSOPHIES

Concepts of education and the rightful role of government in education had to undergo changes in order to develop the philosophy of the Land Grant College (S-5). People in the United States decided the kind of education they would have. They believed in teaching children the fundamentals at the elementary level, and in giving a select group of secondary school-age children a highly classified education to fit them for the university (K-9).

The traditional curriculum at American colleges had grown up during the Middle Ages and had then been quite well adapted to the training of the leading educated class, the clergy. Accordingly, there was a tendency to neglect modern science. As time went on this traditional learning seemed less and less suited to the contemporary world (S-5).

There was increasing demand that the classical elements be supplemented by materials of more immediate significance (S-5). The need for changes in education seemed to be underlined by the democratic ideal that the "common man" be given educational opportunities equal to those of the aristocrat. Since farming was basic to the American economy, it seemed logical that the newer education should pay attention to agriculture. Early promotion of agricultural studies in colleges was sponsored by several agricultural societies in a number of states around 1850. Engineering was also receiving increased support. Home Economics was introduced in curriculums early in the nineteenth century (S-6).

Mathematics and natural science were being taught in several colleges by the middle of the nineteenth century (S-6). Beginning with Michigan in 1855 three state agricultural colleges came into existence (S-7).

Many were of the opinion that federal activity in education endangered the liberties of the American people and should be left to private or state enterprise. These objections caused President Buchanan to veto the first land grant bill passed by Congress (S-6). Modification of this philosophy of government was required before the land grant college philosophy could emerge.

Justin Smith Morrill, a representative from Vermont, like many contemporaries was dissatisfied with American education as it then existed. It conferred undue favors upon wealth and social position. Sons and daughters of farmers and laborers should receive education equal to, but not necessarily identical to, that provided in the existing "literary or classical" colleges. The federal government had been extremely generous in helping manufacturing, commerce and transportation while doing little for the humble classes. The situation, he said, should be remedied (S-7).

MORRILL ACT

The Morrill Act finally passed Congress and was signed by President Lincoln July 2, 1862 (K-10). The Morrill Act provided grants of public land to states for the "endowment, support and maintenance of at least one college (in each state) where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts in such manner as the legislatures of the states may respectively prescribe in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life" (S-7).

Each state was granted 30,000 acres of public land for each senator and representative it had in Congress. The land or land scrip (the latter for states which had already exhausted their public lands) was to be invested, the proceeds to constitute a perpetual fund (S-7).

Proceeds of sales of this land were to be used in the state as a perpetual fund, the interest from which was to be appropriated for the support of "at least one college."

When the Enabling Act, which divided Dakota Territory and admitted South Dakota to the

Union on February 2, 1889, had passed Congress and was signed by the President, the Agricultural College received 160,000 acres of land for its continued support. For each of the representatives and senators, four in all, the college got 30,000 acres for a total of 120,000 acres. The additional 40,000 acres that made the total 160,000 was a Congressional grant to the College in lieu of any grant of saline lands to the states (K-11).

The second Morrill Act, which was approved August 1890, established land grant colleges in the South for Negroes. It made not only the income from lands available to all land grant colleges but appropriated cash for the operation of the institutions, too. The records show that \$66,000 was received by the South Dakota Agricultural College in 1891 (K-37).

The Regents stated in 1890 that little money was needed from the state to operate the College and that the state was almost entirely relieved from any expense in supporting the Agricultural Experiment Station (K-37).

Authorization of an Agricultural College

For 19 years the Territorial Assembly of the sparsely-settled, newly-formed Dakota Territory paid little attention to higher education. Though the politically strong areas had divided the institutions in 1862--the capital at Yankton, the university at Vermillion and the penitentiary at Bon Homme--no further action was taken concerning the latter two. However, it appeared that the location of the penitentiary might be changed (K-11).

When the Territorial Legislative Assembly of Dakota met at Yankton from January 11 to March 7, 1881, Attorney James O'Brian Scobey of Brookings was councilman from his district, an office equivalent to a state senator (K-12). There is little doubt that the people of Brookings expected Scobey to secure some political handout from the assembly (K-12).

The 1881 legislative session seemed to promise a fair number of political plums and Scobey felt that Brookings might as well get its share. His first objective (according to his law partner, G. A. Mathews) was the territorial penitentiary; failing that, he thought a college would bring a certain amount of economic benefit and prestige to his town. Moreover, if Brookings did not seize this opportunity, some other more enterprising community would. As the *Daily Press and Dakotan* observed, "State and territorial ... schools are in large demand this year, and the four corners which fail to secure one are out of luck" (S-11).

The Territorial Assembly on February 21, 1881, approved the establishment of the Agri-

cultural College at Brookings. The measure that Governor Ordway signed made no appropriation for the college. It merely provided for its location in Brookings on the condition that within one year a tract of land of not less than 80 acres adjacent to the town be secured and donated to the Territory in fee simple. Scobey's bill caused little controversy although it was in danger of being lost temporarily in a large number of similar projects proposed that year (S-11). Normal schools were authorized for Madison, Springfield, Spearfish, Alexandria and Watertown (K-12).

ESTABLISHMENT OF LAND GRANT COLLEGE

On April 4, 1881, a Board of Trustees for the College was constituted. The next step was for the citizenry of Brookings to provide the land, as specified in the legislative enactment. There was some delay about this. On August 8, 1881, the *Brookings County Press* warned that failure to fulfill the terms in the requisite time might cost the community this valuable local institution. Thus prodded, the citizens called a meeting on August 20 to decide how to obtain the 80 acres (S-11).

Several tracts were available for approximately the same price and after discussion it was decided to purchase one northeast of town. There was a problem of raising the purchase price of \$600, but this was fairly easily solved by drawing up a subscription paper, following which \$400 of the purchase price was pledged that same night. The remaining \$200 was promised by nine o'clock the following morning (S-11).

A 1883 law made an appropriation of \$25,000. Following its passage, three men were chosen as directors and assigned to see that the college building was erected. On April 19, 1883, this board advertised for plans and specifications and on July 4 the building contract was awarded to a Mankato, Minnesota, contractor. The following day a ground breaking ceremony, accompanied by prayer, was held.

The next event was a financial crisis resulting from the territorial treasurer being unable to sell the college bonds at par (because of the low interest rate). Brookings once more came to the rescue, and its citizens paid \$1,000 to dispose of these bonds (S-12).

The original plans called for an edifice of three parts with Central as the south wing. That proved overly ambitious, and only the middle section appeared in drawings of Dakota Agricultural College sent out in early literature and advertising. By the start of the winter of 1883-1884, the first structure (Central, then called simply the "College Building") was partially enclosed, however,

during the ensuing months snow drifted into the basement, froze, and packed so as to injure the foundation walls (S-12).

On June 2, 1884, the Board of Regents held a meeting at the Commercial Hotel in Brookings. It decided to hire a College president for a 2-year term and appoint two regents to act with him in formulating a course of study and choosing texts (S-12).

At this meeting the board accepted an oral report recommending the breaking of about 25 acres of ground around the College Building. It also selected the faculty, including the first President, George Lilley, who besides administrative duties, was also supposed to teach mathematics and engineering (S-13).

During the latter half of August 1884, a circular announcing the September 24 opening of the preparatory department was distributed. Since the rooms of the College Building were still not finished by mid-1884, it was necessary for Lilley to advance \$500 of his \$1,500 yearly salary before he could have a school over which to preside. The opening ceremonies of the preparatory school were held as scheduled on September 24, 1884 (S-13).

Besides the president, the following men were designated as professors: C. A. Kelsey, a local physician who taught natural science,

and William Phillips, professor of literature and science of languages. The services of Dr. Kelsey and of "Professor" Parker, who taught vocal music, were apparently donated gratis to the College (S-13). Mrs. Nancy Van Doren was preceptress (S-16).

FUNCTIONS OF A LAND GRANT COLLEGE

Traditionally a college or university is thought of as an institution of higher learning. High school graduates pursue courses of training in undergraduate and graduate studies required for the granting of baccalaureate and advanced degrees. South Dakota State, like most Land Grant Colleges, had four major activities--Teaching (resident instruction), Research, Extension and Statewide Services.

Resident instruction became a function of the College when the doors opened in 1884. Research became an activity when the Agricultural Experiment Station was established in 1887. Extension activities began with a Farmers' Institute in 1888. From time to time the legislature made special appropriations for such institutes; and Extension became a permanent function with the establishment of the Cooperative Extension Service in 1914. Statewide Services was established as a separate function in 1923. It was merged with the Experiment Station in 1959.

FOURTEEN PRESIDENTS

The tenure of presidents ranged from 2 to 17 years, and there was considerable variation in their training.

George Lilley	June, 1884-6/22/1886	
Dr. Lewis McClouth	Feb., 1887-1896	Physics
Dr. John W. Heston	6/16/1896-6/30/1903	Law
Dr. James W. Chalmers	7/1/1903-12/30/1905	
Dr. Robert L. Slagle	1/1/1906-1/31/1914	Chemistry
Ellwood C. Perisho	7/1/1914-6/30/1919	Geology
Dr. Willis E. Johnson	1919-6/30/1923	Geography & Civics
Dr. Charles W. Pugsley	9/1/1923-6/30/1940	Agriculture
Dr. George L. Brown	7/1/1940-12/31/1940	Mathematics
Dr. Lyman E. Jackson	1/1/1941-1/31/1946	Agriculture
Dr. Fred H. Leinbach	1/1/1947-6/30/1951	Animal Husbandry
Dr. John W. Headley	1/1/1952-11/19/1957	Administration
Dr. Hilton M. Briggs	6/4/1958-6/30/1975	Animal Husbandry
Dr. Sherwood O. Berg	8/1/1975-	Agricultural Economics

COLLEGE NAMES

South Dakota State University was referred to as the Agricultural College by the 1881 Territorial Legislature. Two years later it was designated as the Agricultural College for the Dakota Territory.

In 1887 the Territorial Legislative

Assembly met for the first time in Bismarck, the new capital. It changed the name of Agricultural College for the Dakota Territory to Dakota Agricultural College (K-30).

The name of the college was changed to South Dakota Agricultural College when South Dakota became a state in 1889.

Shortly after Dr. Robert L. Slagle became president in 1906, he suggested that the name of South Dakota Agricultural College be changed to South Dakota State College of Agriculture and Mechanic Arts (K-53). The legislature of 1907 adopted the suggestion, and the name was used for 57 years (K-51).

In 1962 when Dr. V. V. Volin of Sioux Falls was president and this writer was Vice President of the SDSC Alumni Association, the board of directors voted to conduct a campaign to change the name to South Dakota State University.

The regent's minutes of July 1963 include a resolution to request the Legislature to change the name of South Dakota State College of Agriculture and Mechanic Arts to South Dakota State University.

The change was authorized by the 1964 legislature and became effective at the beginning of the next fiscal year, July 1, 1964 (K-143).

ORGANIZATION

Departmental and divisional organization followed the trend of institutional growth. As enrollment increased, the faculty was enlarged. With more instructors, a wider variety of courses could be taught in greater depth. With an increased number of courses in any given discipline, it was possible to group them in departments.

Departments and Faculty

When the doors opened for classes in September of 1884, there were three salaried instructors--the president, one professor and one preceptress. Two other professors apparently donated their time (S-13). The faculty was increased shortly. The second biennial report listed 11 professional and two operational employees (K-26).

Departments as they are known today would have been meaningless with a faculty of that size. Agriculture at that time included farm management, horticulture, forestry, botany and animal husbandry (S-42).

When the Agricultural Experiment Station opened in 1887, the staff included professors of Agriculture, Botany-Horticulture-Forestry, Entomology-Zoology-Physiology, Chemistry and Veterinary Science (Wilson, p. 84). Though it has been said that there were five departments with one person in each, they could not have been departments as they are known today.

Some departmental organization was beginning to manifest itself during the McLouth administration, but it was not until President

Heston's time that groupings became definitely established (S-24).

The college boasted of 24 departments in the school year of 1897-1898 but the catalog only listed 23 of them. Those pertaining to agriculture included Agriculture, Botany, Chemistry, Dairy, Geology-Agronomy, Horticulture, Steam Engineering and Zoology (K-43). Among the 23 departments were the Experiment Station, which had no teaching, and Preparatory, which only provided courses for high school students.

After 1900, enrollment increased rapidly and a larger faculty was required. When President Slagle took office in 1905, the faculty numbered 34. By June 1912 there were 60 faculty members (S-29).

More departments were created--Civil Engineering in 1902, Music in 1905, Electrical Engineering in 1907, Dairy in 1907, Animal Husbandry in 1908, Education in 1916, Physical Education in 1917, Printing in 1920 and Entomology-Zoology in 1920 (S-43).

During the Pugsley administration departmental status was given to speech in 1923, Agricultural Economics, Agricultural Engineering, Printing and Rural Journalism, Poultry, and Rural Sociology in 1925, and Nursing Education in 1935 (S-32, Cir-123).

There were 34 departments in 1932 (K-79). Five years later there was a professional staff of 171 and 11 graduate students to carry on teaching and research (K-87).

In 1958 there were 46 departments and 549 staff members. Seventeen years later there were 44 departments and 696 faculty.

Some of the new departments were Aerospace Management, Continuing Education, Geography, Health Science, Nutrition and Food Science, Political Science and Psychology. Several departments changed names to include a larger area of study (such as Botany-Biology; Health, Physical Education and Recreation) while some have split from areas they once encompassed (such as History-Geography). (17 yrs-5).

Among departments pared were Library Science, Plant Pathology (which combined with Plant Science), Poultry Husbandry (which combined with Animal Science), and Rural Nursing which became Public Health Nursing. Curriculum in the Home Management and Equipment Department was integrated into other departments, and two departments in the College of Pharmacy (Pharmacognosy and Pharmacy) were discontinued (17 yrs-5).

In 1979 the Entomology-Zoology Department

was dissolved. Entomology was placed in the Plant Science Department, and Zoology was combined with Botany-Biology to form the new Biology Department.

Divisions and Colleges

Under President Johnson the Division of Agricultural was formed on July 1, 1923, with Christian Larsen, MSA, as Dean (K-68). State-wide Services was a separate item in the College budget appropriated by the 1923 legislature (K-70).

The Division of General Science was formed in late 1923 or early 1924 with Dr. G. L. Brown as Dean. Regents' minutes list graduates for the Division of Agriculture and General Science in 1924.

On January 22, 1924, the Regents authorized the formation of the Divisions of Engineering, Home Economics and Pharmacy. H. B. Mathews was Acting Dean of Engineering until Dr. Harold M. Crothers was named Dean in 1925. Edith Pierson was Dean of Home Economics and Dr. Earl R. Serles, Dean of Pharmacy. The 2-year pharmacy course was discontinued and the 3- and 4-year courses strengthened in 1924. Regents' minutes list graduates for all five divisions in 1925.

Nursing Education became a section in the Division of Pharmacy in 1935 and the Division of Nursing in 1956. The Division of General Science, formed in 1925, was renamed the Division of Science and Applied Arts in 1953.

On July 1, 1964, the six divisions became colleges--Arts and Sciences, Agriculture and Biological Sciences, Engineering, Home Economics, Nursing and Pharmacy and the Graduate Division became the Graduate School. A College of General Registration was authorized in 1974 and the Department of Education became the Division of Education in the College of Arts and Sciences in 1975 (17 yrs-5).

TEACHING AND STUDENTS

The college taught high school courses in its Preparatory School from 1884 to 1923 and in the School of Agriculture from 1908 to 1961. Summer School was initiated in the 1920s. The Graduate Division had its first head in 1951, and became the Graduate School in 1964. General Extension, now Continuing Adult Education, for off-campus classes received considerable emphasis after 1964. The College was a training base during two World Wars.

Preparatory School

In 1884 the Regents were determined to establish a college, but their first concern

was to get the Preparatory School operating (K-20). This was necessary because of the shortage of high schools in the Territory (S-13).

On September 23, 1884, the Board of Regents agreed on the "...need of a well organized and thoroughly equipped school, one in which youth may be soundly and completely fitted for the Dakota Agricultural College..." (K-20).

The school was to be an integral part of the College and feeder to it. Its object was to prepare students to enter regular college courses (K-20).

To enter, a student had to be 12 years old and able to do fifth grade work (K-20). The catalog for 1885-1886 indicated that the Preparatory Department included two years (a) Junior year--8th grade and (b) Senior year--9th grade (K-25).

In its first year of classes, 1884-1885, the College was not really a college; instruction was given solely in the Preparatory Department. According to the course outline, the work for the first term was to consist of reading, writing, arithmetic, grammar and geography. In second term, subjects were arithmetic, grammar, geography and U.S. History, and during the third term students were to continue in arithmetic, grammar, American history and also study physiology (S-13).

The 1885 report of the Regents showed that 50 students were admitted when the Preparatory School opened. There were 25 men and 25 women. All were from Dakota and filled the existing capacity of the college (K-20). However, the first catalog showed that during the academic year 1884-1885 there was a college freshman class of 17 (seven from Brookings) and an enrollment of 61 in the Preparatory Department, 50 of whom were from Brookings County (K-25).

The catalog for the year 1886-1887 indicates that the enrollment for the previous year included 89 students in the collegiate program and 162 in the Preparatory Department (K-35).

The Preparatory Department served as the high school for Brookings until 1908.

Enrollment dropped from 86 students in 1918-1919 to 37 students in 1921-1922. The Preparatory School was discontinued on June 30, 1920, though there were some classes in junior and senior years of high school that was continued to meet the needs of "conditioned" students (K-68).

Life in Early Days

Life at the Dakota Agricultural College during the Lilley and McLouth administrations

presented features typical of pioneer education. That the institution was situated on the open prairie was obvious, but that it was not entirely in the midst of a howling wilderness is known from the fact that Brookings had grown from its beginnings in 1879 to a quite respectable town of 1,200 by 1886 (S-16).

A diagonal road led from the College to the vicinity of the present Sixth Avenue and Sixth Street. Although, in the interests of more effective study and avoiding social complications, restrictions were placed on the times when students were allowed to go into town. The three quarters of a mile between the seat of learning and the "bright city lights" was a well traveled highway (S-16).

When John M. Aldrich arrived as a student, he was able to see the school's lone building from a distance of 14 miles. The late 1880s were the years of the great blizzards. During the most famous of these, that of 1888, both the town and college were cut off from the outside world for 10 days. For a time, fuel shortage and famine threatened. Classes continued as usual, but the "*Collegian*" warned that the school might lose a few of its students unless a railing was constructed along the walk into town. Several people had lost their way and it was only by good fortune that they had been rescued (S-16).

In 1930 Aldrich wrote the following for the Power's history.

"The institution was not only new, but the buildings were not completed. There was no library, there were no laboratories, no traditions, no suitable place for students to live. The small faculty contained not a single specialist in anything except music. Some of the professors had not completed a college course, and not one had pursued graduate work in residence in a university. The students were unprepared for college work. Five of them had graduated from a high school and a large proportion had had only country school opportunities (S-17).

"Doctors of philosophy were not needed and would have thrown up their hands. Practical and helpful people we had over us, and they were not far above us either (S-17).

"The first teacher of entomology had never taken a course in that subject. He was, however, wise enough to turn the students loose with the insects, and instruction at least got underway from these informal beginnings (S-17). The college was as deficient in physical supplies as it was in the possession of academic degrees by faculty members. During the first year the sole agricultural equipment was a buckboard and a roan horse, used principally to

transport trunks and students to town and back. The library was a dream, the museum a myth, and the farm was a 20-acre potato patch. Many elements of a college existed only in the catalog (S-17).

"As for the students, there are few indications that boredom was a problem. The desire for learning, if we can believe early reports, was great; Moreover, there was plenty to do. The physical labor necessary for taking care of the College was, for the most part, performed by students. This was a matter of necessity and was also given philosophical justification by the contemporary manual labor concept under which the mental and physical powers were presumed to develop best in unison. Almost all of the students were self-supporting. The south end of the campus was used as a market garden, and some paid expenses by raising tomatoes, cabbages and other articles. These were sold by the college authorities (S-17)."

The first cigarette was said to have been smoked on the campus in 1892. The great majority of early students do not seem to have used tobacco in any form, and there was a long standing tradition, more or less in effect until the early 1930s, against smoking either in the buildings or on the campus. Dancing was likewise a taboo at first (S-18).

The lack of trained teachers is evident from the fact that one member of the faculty had the title "Professor of Political Economy, Practical Business, Military Tactics, and Principal of the Preparatory School" (K-27).

The School of Agriculture

The School of Agriculture was established in 1908 with the purpose of providing "agricultural and homemaking training for older rural youth who did not enter high school." Agricultural and homemaking subjects comprised nearly half of its curriculum, but regular high school courses were also included (S-48).

In 1941 a policy was adopted whereby students of post high school age were especially encouraged to enroll although any students interested in agriculture and 16 years of age might be admitted. The level of instruction for post high school students was to be of an advanced nature as compared with 4-H club work and high school agriculture (S-48).

In the late 1940s the housing situation caused the school to be limited to male students. In 1946 the minimum entrance age was raised to 16. Practical experience and graduation from high school were preferred for admission but neither was required. Classes were held separately from college classes, but

members of the College staff, together with regular School of Agriculture faculty, did the teaching (S-48). Several young people started their secondary education in the School of Agriculture and remained to be graduated from the College. The school was closed on June 30, 1961 (K-54).

Summer School

Slagle was responsible for getting Summer School started and, although the format changed from time to time, the school is still (in 1975) carried on with 5-week and 6-week terms running simultaneously to accommodate the needs of different types of students (K-57).

The summer session gave students enrolled during the regular school year a chance to accelerate programs as well as make up courses they had missed. Graduate students, the largest number being teachers in service, were also afforded an opportunity to progress toward advanced degrees. The number of such graduate students in the summer session multiplied several times in less than a decade (S-56).

In addition to regular classwork, Summer School constantly augmented the scope and interest of its assembly and special events programs. It offered an ever widening variety of short courses to meet the needs of such diverse groups as, for example, Extension personnel and school cafeteria cooks (S-56).

School Calendar

The college calendar in 1884 utilized the quarter system with three terms starting in the fall and ending in the spring (K-20).

Four years later President McLouth instituted a new college calendar with the school year beginning in March and ending in December. There were several reasons for this, including a desire to save fuel. It was also maintained that students in an agricultural college should be in school during the growing season as they could help with crops and experimentation (S-19).

Shortly after the coming of President Heston, the calendar was changed again. The 1895-1896 catalog announced that for the next year, 1896-1897, the regular school calendar would still be three 10-week quarters with a long winter vacation from November 12, 1896 to February 10, 1897. The spring term would end July 14, 1897 (K-42).

By 1897-1898 a completely new calendar, with 12-week quarters, had been adopted. The fall term of 1898 began September 23 and ended

December 1. Following a 6-week vacation, the winter term began January 7, 1899. The spring term started March 25 and ended June 1, 1899. An 8-week summer school ran from July 25 to September 16 (K-42).

The quarter system lasted until the presidency of Robert Slagle who changed the calendar to the semester system where it stayed until World War I when the quarter system was reinstated (K-42).

The quarter system was followed for about 45 years. In 1961 the Board of Regents decided that all seven state supported institutions should have the same system. The University of South Dakota and one other college were using the semester system and the board decided that the other five institutions should change to that schedule. Such a change had been discussed by SDSC faculty on several occasions. Each time a proposed change to the semester system was voted down.

College Proper

The first circular listed four college programs: Agriculture--4-year course; General Scientific Course--4-year course leading to a B.S. degree; Civil Engineering--4-year course and Mechanical Engineering--4-year course (K-20).

The catalog for the academic year of 1885-1886 indicated that Bachelor's degrees would be granted in Agriculture, Agriculture and Domestic Economy (for ladies), Civil Engineering, Mechanical Engineering and a Literary course (K-25).

However, Agriculture was not taught because a qualified teacher could not be located until Luther Foster became Agriculturist in 1886.

The teaching of Military Science was a requirement of land grant colleges. In 1888 application for a regular military detail was made to the War Department. Two years later Lt. Perry Leary became commandant and organized the military department (S-53).

The first baccalaureate degree was awarded the week of June 24, 1886, to Marcus A. Saylor of Swan Lake (K-26). The first regular commencement exercises were on August 9, 1888, the graduates being Lulah Wellman, John M. Aldrich, and Aubrey Lawrence. Aldrich's progress is said to have been accelerated by President McLouth's desire to have a graduating class in 1888 (S-19).

Aldrich was a student in Agriculture and Wellman studied Home Economics. The first two Engineers and first Pharmacy students did not finish until 1891. Saylor had a rural back-

ground, and may have studied Agriculture except that few Agriculture courses were taught before he graduated. He and Lawrence may have been in Agriculture or one of them may have been the first graduate in General Science.

In 1891 Aldrich received the first Masters degree conferred by the institution. He was the first alumnus to receive an appointment to the faculty and served as Assistant Entomologist from 1888 to 1891.

Courses offered in 1895-1896 included 4-year courses in Agriculture, Domestic Science and Mechanical Arts; 2-year courses in Pharmacy and Business and short courses in Steam Engineering, Dairy, Cheese Making, Agriculture, Latin and German (K-34).

By 1901 the college had conferred 206 Bachelor of Science Degrees, 22 Master of Science Degrees and five degrees in Pharmacy (K-44).

The first mention of majors was made during the Heston administration. The 1903-1904 catalog listed courses in Scientific Agriculture, Domestic Science, Mechanical, Electrical and Agricultural Engineering and Pharmacy. General Science was the only liberal arts major available then and for many years later (S-42).

The basic programs available in 1907-1908 were Agriculture, Mechanical Engineering, Civil Engineering, General Science, Home Economics and the Preparatory Program. Civil Engineering and Agricultural Engineering had been combined in 1904-1905 (K-54). Two education courses were listed in 1911-1912 (K-55).

The college was gradually increasing in size, but during the administration of President Slagle, enrollments increased to a remarkable extent. When he took control in 1905 there was a total registration of 570; this, by the end of 8 years, had grown to 903 (S-29).

On December 5, 1913, the Regents passed a resolution which stated that smoking of tobacco on the main campus around the outside of the buildings, upon approaches to and in the corridors of buildings, in recitation and public assembly rooms, was forbidden (K-61).

The enrollment dropped to 327 during World War I in 1917-1918. However, during the Johnson administration it soared to 698 which was the highest number up until that time.

During the Pugsley administration, student enrollment grew from 698 in 1923-24 to 1,161 in 1930-31, then dropped to 774 in 1934-35 and raised to 1,376 in 1939-40 (S-68).

At that time the College was using an aca-

demical calendar of three quarters with a 6-week summer session. Though the institution had lost some courses during the depression, the Division of Agriculture had 4-year programs in Technical Agriculture, Agricultural Science, Agricultural Engineering, Industrial Arts and Wildlife Techniques and a 2-year program in Pre-forestry, the School of Agriculture and numerous short courses (K-86).

Agricultural Engineering had been transferred from the Division of Engineering to the Division of Agriculture. Botany-Bacteriology was in the Division of General Science until 1941 when it was transferred to the Division of Agriculture.

During World War II, there were a number of changes in courses and requirements. Physical education was compulsory for both freshmen and sophomores, various 2-year curricula were instituted, and a number of faculty members spent extra hours teaching unscheduled mathematics and physics sections. Women students took welding in the college shops, and preinduction courses were held for prospective members of the armed forces (S-35).

The war had a marked impact upon student social activities. The traditional sex ratio of 4:1 favoring the men was reversed, 276 women and 107 men having registered in the fall of 1943. In the spring of 1944 about nine-tenths of the civilian students were women (S-35).

The "manpower shortage" was relieved by the presence of military trainees using college facilities. A total of 5,796 went through army programs between December 3, 1942, and June 30, 1944 (K-94). The peak number of trainees on the campus was 1,480 (S-36) higher than previous college enrollment for any year except 1940-41.

After the war, enrollment was swelled by the return of servicemen. The initial enrollment of veterans under the GI Bill took place in the spring of 1944. The trickle of ex-servicemen became a torrent by the beginning of 1946. Traylor "houses" mushroomed in the College Grove to provide housing for married veterans (S-36).

In 1947-48 the college enrollment of 2,426 included 1,343 veterans. Their tuition and fees and some living expenses were paid by the U.S. government and the college income was greatly enhanced. However, veterans enrollment dropped to 657 in the spring of 1950 and even lower after that (K-100).

During the Headley administration enrollment increased from 1,618 in 1951-1952 to 3,824 in the fall of 1958. Under the Briggs administra-

tion enrollment rose from 3,824 in 1958 to 6,181 in 1974. In 1971's peak enrollment, the increase grew to 70.6 percent at 6,522 students (17 yrs-8). Slight declines were noted for the next few years.

In 1958, the catalog listed 1,618 courses and 120 majors and options in 46 departments. In 1974 some of the figures looked remarkably similar: 1,640 courses and 182 majors and

options in 44 departments (17 yrs-5).

A variety of majors were added, deleted and up-dated. Some of the new majors were Environmental Management, Biology, Agricultural Science, Park Management, Biological Science, Food and Nutrition, Chemistry, Geography, Health Education, Physical Therapy, Public Recreation, Extension Home Economics, Interior Design, and Health Science (17 yrs-5).

Fall Term Enrollment

<u>School Year</u>	<u>Enrollment</u>	<u>School Year</u>	<u>Enrollment</u>	<u>School Year</u>	<u>Enrollment</u>
1884-85	17	1917-18	373	1950-51	1,859
1885-86	90	1918-19	434	1951-52	1,618
1886-87	56	1919-20	405	1952-53	1,936
1887-88	130	1920-21	416	1953-54	2,073
1888-89	129	1921-22	576	1954-55	2,328
1889-90	177	1922-23	679	1955-56	3,015
1890-91	174	1923-24	698	1956-57	3,215
1891-92	188	1924-25	752	1957-58	3,534
1892-93	195	1925-26	848	1958-59	3,824
1893-94	116	1926-27	909	1959-60	3,413
1894-95	153	1927-28	917	1960-61	3,050
1895-96	124	1928-29	929	1961-62	3,139
1896-97	257	1929-30	1,028	1962-63	3,476
1897-98	352	1930-31	1,161	1963-64	3,778
1898-99	295	1931-32	944	1964-65	4,207
1899-1900	308	1932-33	868	1965-66	4,637
1900-01	242	1933-34	710	1966-67	5,013
1901-02	193	1934-35	774	1967-68	5,467
1902-03	142	1935-36	981	1968-69	5,767
1903-04		1936-37	1,088	1969-70	6,068
1904-05		1937-38	1,172	1970-71	6,252
1905-06	166	1938-39	1,295	1971-72	6,522
1906-07	188	1939-40	1,376	1972-73	6,386
1907-08	187	1940-41	1,501	1973-74	6,217
1908-09	175	1941-42	1,358	1974-75	6,181
1909-10	183	1942-43	1,195	1975-76	6,412
1910-11	193	1943-44	446	1976-77	6,464
1911-12	192	1944-45	395	1977-78	6,488
1912-13	251	1945-46	1,053	1978-79	6,537
1913-14	286	1946-47	2,107	1979-80	6,464
1914-15	297	1947-48	2,426	1980-81	6,868
1915-16	373	1948-49	2,320	1981-82	7,100+
1916-17	381	1949-50	2,267		

STATEWIDE SERVICES

Statewide Services became a separate arm of SDSC in 1923. Initially it included the Seed Testing Laboratory in the Agronomy Department and animal disease diagnostics in the Veterinary Department. Shortly afterwards Station Biochemistry started making chemical analyses to determine feed value of feed and forages

and water quality.

In the Agronomy Department, the Foundation Seed Stocks Division was added in 1943, Seed Certification Service, Soil Testing Laboratory and Soil Survey in 1947 and Variety Performance Testing in 1961.

The budget for Statewide Services was

included in the Experiment Station budget by the 1959 legislature and the two budgets have been handled as one since July 1, 1959.

Other Services

Several new services, laboratories and institutions were added to SDSU during the 1960s. Some may be considered as part of Statewide Services, but others are not.

Early in the 1960s a museum was established in the basement of Wenona Hall under the direction of Ralph Johnston. Later, Henry DeLong was named Museum Chairman after Mr. Johnston requested he be relieved of that duty. The museum is now the Agricultural Heritage Museum of the State Board of Cultural Preservation. Since 1975 it received state funding for a full-time staff (K-139). When the Animal Science Building was completed in 1975, it left the Livestock Pavilion vacant. The museum moved to that location.

The first computer was brought to the campus in 1961. A second machine was added in 1964 and all student records, accounting and payroll procedures were automated. In 1967 the two computer systems were combined and another machine was added. Grade reporting and budget planning were added to the list.

Machines added in 1974 included magnetic tapes which made it possible to process data four to eight times faster (17 yrs-25).

In 1961, The Northern Grain Insect Research Laboratory was completed on the campus. Scientists there held courtesy appointments on the University staff and the facility was valuable in teaching as well as for research (K-146).

A bill before the U.S. Senate proposed the establishment of two such Laboratories in Iowa and Mississippi. However, senators from those states were absent when some of the final working was put in the bill. Senator Karl Mundt of South Dakota and a colleague from North Carolina succeeded in substituting the names of their states as locations. The bill passed in the spring of 1959 and specified that the state must provide land for the facility before July 1 so that contracts for construction could be awarded.

The South Dakota Legislature, which must approve any construction on state land, had already adjourned; consequently, permission to build on the campus could not be obtained.

The Larson Farm, however, had been purchased by the South Dakota State College Development Association in 1950. It leased the land to SDSC with the understanding that the college would receive title when enough rent had been paid to repay the principal and interest. Since SDSC was scheduled to obtain the title in 1963, the Laboratory was built on that farm about a mile from the main campus.

At the close of the 1963-1964 fiscal year the institution had "closed circuit" television. This situation was improved markedly in the next few years. Dr. Briggs reported at the end of the 1962-1964 biennium that the college had received from KELO-TV of Sioux Falls a valuable gift that would be of great help in establishing "Broadcasting TV." The materials received by the institution included a tower and cameras. Now State University was equipped for closed circuit television, public television and FM radio broadcasting (K-144).

The Water Resources Institute was established Oct. 8, 1964, as an administrative unit of SDSU. The institute's mission was to coordinate research and education at SDSU and other educational institutions and agencies in the state in the broad area of water resources (17 yrs-30).

Statewide Technical Assistance Through Extension (STATE) was inaugurated in 1967. Under the State Services Act of 1965, STATE, an engineering extension function, was funded federally in 1967 for 3 years to provide and maintain a field of Engineering service of technical assistance to small business and industry. It went under South Dakota funding in 1970 (17 yrs-31).

In 1968 the \$600,000 Animal Disease Research and Diagnostic Laboratory was built. It set the example for similar facilities throughout the nation. It was one of the first to receive accreditation by the American Association of Veterinary Laboratory Diagnosticians, and was regarded as one of the finest in the country (17 yrs-31).

The Remote Sensing Institute began operations in 1969 under the directorship of Victor I. Meyers, who, as project manager for USDA, SWC at Weslaco, Texas, had helped develop the use of remote sensing data in agriculture. RSI was one of the most completely equipped units of its kind in the U.S. In 1974 it had a staff of 10 professionals, 8 technicians, and 5 part-time employees (17 yrs-8).

CHAPTER X AGRICULTURAL EXPERIMENT STATION

All research work in agriculture and home economics was done under the auspices of the South Dakota Agricultural Experiment Station.

Agricultural research has progressed with the state. In fact, the early experimental work began before South Dakota was admitted to statehood. Federal funds to establish an experiment station in the Dakota Territory were made available under the Hatch Act in 1887 (Cir 123).

Sources of information used in this chapter include the first half of Chapter VI (written by J. W. Wilson) of the history edited by William H. Powers, a mimeographed report compiled by Lyle A. Derscheid in 1954, a history by Charles L. Sewery in 1959, and several Agricultural Experiment Station bulletins and circulars. The source of information is indicated by "W", "LAD" or "S" and appropriate page number or by "Bul" or "Cir" and number.

HATCH ACT

The Agricultural Experiment Stations were established by Section 1 of an Act of Congress approved March 2, 1887, entitled "An Act to establish Agricultural Experiment Stations in connection with the colleges established in the several states, under the provisions of an Act (Morrill Act) approved July 2, 1862, and the acts supplementary thereto" (W-83).

The Act also provided funds, known as Hatch Funds, for conducting certain types of agricultural research.

Territorial Acceptance

The Seventeenth Legislative Assembly of the Territory of Dakota in 1887 reorganized the Dakota Agricultural College and added the Experiment Station. Section 17 of the Act provided that "there is hereby established an Agricultural Experiment Station in connection with the Agricultural College of Dakota, and under the direction of the Board of Regents of said college for the purpose of conducting experiments in agriculture, according to the terms of Section 1 of the Hatch Act (W-83).

The Legislature also appropriated \$8,000 to purchase land for the Experiment Station (K-35).

EXPERIMENT STATION DIRECTORS

Pres. Lewis McLouth	1887-1890
Luther Foster M.S.A.	1890-1892
Pres. Lewis McLouth	1892-1895
James H. Shepard M.A.	1896-1901

Pres. John W. Heston	1902-1902
James W. Wilson M.S.	1902-1938
Isaac B. Johnson M.S.	1938-1956
Dr. Max Myers	1957-1958
Dr. Orville G. Bentley	1958-1965
Dr. Duane C. Acker	1966-1974
Dr. Alfred L. Musson	1967-1973
Dr. Raymond A. Moore	1974-

At first the Experiment Station was under the supervision of a "Council of Control", which consisted of President McLouth, who was made director, and the professors of Agriculture, Horticulture, Entomology-Zoology-Physiology, Chemistry and Veterinary Science. The duties of each member of the council were outlined in detail and the general operations of the Experiment Station were delineated (W-83).

Professor Luther Foster was appointed Director in 1890 (W-84). His name appeared as superintendent of agricultural experiments in bulletins written from 1889 to 1891.

At the end of 1892 President McLouth resumed charge of the station although his name does not appear in reports as Director until 1894. J. H. Shepard appeared as Director in the ninth report, June 1896, and continued so until 1902, when for a short time President Heston acted as Director until the appointment of J. W. Wilson in May 1902 (W-84).

Wilson held the position until he retired June 30, 1938. I. B. Johnson served as Director until he retired on June 30, 1956. When Dr. O. G. Bentley became Dean of Agriculture on October 1, 1958, he also became Director of the Experiment Station. He named A. L. Musson, Head of the Animal Husbandry Department, as Assistant to the Director in 1959. Dean D. C. Acker named Musson as Associate Director, a title held by R. A. Moore for about a year. Sometime after Dr. Delwyn D. Dearborn became Dean, he changed Moore's title to Associate Dean and Director of Experiment Station.

DIRECTOR'S OFFICE

It is speculated that the Director's office was first located in Central and that it moved to the Agricultural Building which was completed in 1899. It was moved to the Agriculture and Administration Building, perhaps in 1913 when the south half of the building was occupied or in 1918 when the north half was added.

Director I. B. Johnson officed in Room 122 on first floor immediately inside the main entrance as early as 1939. While Johnson was still Director, the office was moved to Agri-

cultural Hall during the summer of 1952. Johnson and then Myers occupied the southeast 3-room suite of offices (Room 135).

When Dr. O. G. Bentley became Dean of Agriculture and Director of the Experiment Station in October 1958, he took the 5-room suite of offices across the hall (Room 154) that had been occupied by Dean Eberle. Dr. A. L. Musson officed in Room 154B in the suite. Dr. R. A. Moore used the same office for about a year then Moore moved to Room 152C in 1975.

DEPARTMENTALIZATION AND STAFF

The first five professors were I. H. Orcutt, Charles A. Keffer, James H. Shepard, Luther Foster and probably C. J. Alloway.

I. H. Orcutt was professor of natural sciences in 1885 and professor of Entomology-Zoology-Physiology in 1887. The next year he initiated entomological investigations (Balsbaugh) at the same time that J. M. Aldrich, a member of the first graduating class, was named assistant entomologist.

Keffer, the horticulturist, had charge of botany and forestry. In 1889 he was listed as superintendent of horticultural and forestry experiments (Bul 9). He was relieved of some of his responsibilities when T. A. Williams, the first botanist, was hired in 1891 (W-87).

Shepard and Foster joined the college staff in 1886. Shepard, the chemist, initiated research in biochemistry in 1888 (Cir 123). Foster, the agriculturist, started research in agriculture in 1888. He was listed as superintendent of agricultural experiments in 1889 (Bul 9). Agriculture at first included agronomy and animal husbandry (W-85).

Alloway was veterinarian as early as 1889 (Bul 9).

Although Foster, the first agriculturist, wrote a number of bulletins on crops, it was not until the time of his successor, E. C. Chilcott, that agronomy, strictly speaking, can be said to have been organized. Chilcott was appointed in February 1893, but was superseded for a short time by E. A. Burnett; it was when Chilcott returned that his valuable contributions were made. He initiated an extensive experiment in crop rotation in 1897 (W-84).

Geology-Agronomy was listed as a department in the college catalog for 1897-1898 (K-43). The Department of Agronomy was created in 1903 (Cir 123).

In the early years animal husbandry was combined with agriculture. For a short time

in 1899, E. A. Burnett was on the staff as animal husbandman. In 1902 J. W. Wilson was made Director and animal husbandman and since that time animal husbandry has been a major activity (W-85). The Department of Animal Husbandry was established in 1903 (Cir 123).

The dairy work was not independent of the agricultural department until 1890 when A. H. Wheaton, president of the board of trustees, was appointed dairyman. There was no dairyman from 1895 to 1901, when Wheaton was reappointed for a short time. With the appointment of C. Larsen in 1907, the department became permanent (W-85).

In the beginning veterinary was a department of the station. Yet from 1895 to 1902 there was no veterinary department, though for most of this time there was a zoologist on the staff who was really a veterinarian. The department was not listed again from 1913 to 1922 (W-85-6).

Though several botanists were on the Station staff for several years, there was not a botanist on the station staff after 1912. Entomology and zoology in 1920 were combined into one department.

Though it was said in 1892 that state funds would not be needed for the Experiment Station, the people of the state wanted more from the Station than could be obtained with federal funds.

Additional funds became available through state appropriations and federal allocations set up in the Adams, Purnell and Bankhead-Jones acts. These appropriations made it possible in 1925 to establish departments in Agricultural Engineering, Farm Agricultural Economics, Rural Sociology and Poultry. Home Economics was added in 1926 (LAD-18 and Cir 123).

By 1931 the financial support of the station increased from \$15,000 to \$108,924 annually and the number of departments doing station work increased from five to thirteen. Demand rose both at home and abroad for the results of this station (W-90).

Twelve of the departments specifically mentioned were--Agricultural Engineering, Agronomy, Animal Husbandry, Chemistry, Dairy, Farm Economics, Home Economics, Horticulture, Poultry, Rural Sociology and Veterinary Science.

Plant pathology activities were a part of the Experiment Station from 1920 to 1923 while A. T. Evans was employed to develop disease resistant crops. It became a permanent activity in 1940 when W. F. Buchholtz was hired.

In 1956 the departments in the Experiment Station were Agricultural Economics, Agricultural Engineering, Agronomy, Animal Husbandry, Dairy, Entomology, Home Economics, Horticulture-Forestry, Plant Pathology, Poultry, Rural Sociology, Station Biochemistry and Veterinary (Cir 123).

Not only had the fields of research work increased from the original five departments to 13, but the staff of five had increased until in 1954, there are 95 members of the technical staff and 15 research assistants. Most of the members of the technical staff, however, devoted part of their time to research and part to teaching in the College (LAD-18).

Federal funds received from the Hatch, Adams, Purnell, Bankhead-Jones and Copper-Ketchum acts comprised approximately 28% of the grand total expended for research at the South Dakota Agricultural Experiment Station, substations and other outlying farms in 1954 (LAD-18).

The Botany-Bacteriology Department began doing research in 1961 under the Experiment Station. After an absence of nearly 50 years, research activities in botany were resumed. The department was renamed Botany-Biology in 1967 and Biology in 1979. The Wildlife Department, formed in 1963, also became affiliated with the Experiment Station.

Though there was some departmental reorganization on July 1, 1980, there were still 13 departments in the Experiment Station--Agricultural Engineering, Animal Science, Biology, Dairy Sciences, Economics, Home Economics, Horticulture-Forestry, Microbiology, Plant Science, Rural Sociology, Biochemistry, Veterinary Science and Wildlife and Fisheries Science. Statewide Services was also a responsibility of the Experiment Station.

The technical staff included over 200 people. However, most of them were part-time research and part-time teaching or Extension, leaving 157.3 full-time equivalent for research, conducting studies on 184 research projects.

RESEARCH LOCATIONS

At first the research was done on West Farm and the main campus. However, more farms were purchased as indicated in Chapter XIII and numerous outlying experiment stations, discussed in Chapter XV, were established.

Land devoted to research in 1954 included 840 acres at the main Experiment Station and over 13,700 acres at outlying stations. Land utilized for research at the main station near

the campus included 220 acres for agronomic research, 35 for plant pathology, 55 for horticulture, 22 for poultry, 380 for animal husbandry, 95 for dairy and 10 for agricultural engineering (LAD-18).

In order to develop crop, soil, livestock and engineering practices and to secure other information tailored to South Dakota, three substations, two field stations, two development farms, three research farms and numerous experimental plots could be found throughout the state in 1954. The technical staff at the main station supervised the work on these outlying research centers (LAD-17).

The Central Substation near Highmore in Hyde County comprised 117.5 acres. The North Central Substation near Eureka in McPherson County covered 240 acres and the Range Field Station, located near Cottonwood in Jackson County, consisted of 632 acres of state-owned land plus 2,000 acres of Land Use land adjacent to the station. At all the three substations daily precipitation, temperature and various other weather data were recorded (LAD-19).

The Antelope Range Field Station located in Harding County included 8,300 acres and Reed Ranch near Presho in Lyman County had a total of 1,920 acres. Work was also carried out in cooperation with the United States Department of Agriculture on 360 acres located at the Irrigation and Field Station near Newell in Butte County (LAD-19).

The Shadehill Development Farm, near Lemmon in Corson County, consisted of 40 acres, and the Redfield Irrigation Development Farm in Spink County had 115 acres set aside for research. Both farms belonged to the Bureau of Reclamation but Experiment Station staff carried on the research in irrigation (LAD-19).

Three research farms were leased by the Experiment Station--a 40-acre Leafy Spurge Research Farm northwest of Gary in Deuel County, a 14-acre Russian Knapweed Research Farm west of Conde in Spink County and a 10-acre farm near Plankinton in Aurora County was established to conduct soil research.

EARLY ACHIEVEMENTS

Early experiments were conducted in raising corn, wheat, oats, barley, potatoes, clovers, sugar beets, mangels, millets and breeds of livestock. The Experiment Station had twelve different breeds of purebred livestock: Percheron horses, Aberdeen Angus, Hereford, Holstein-Friesian and Shorthorn cattle; Merino and Shropshire sheep; and Poland China, Berkshire, Duroc Jersey, Chester White and Yorkshire swine (W-83).

Plant Sciences

By 1931 the work of the Station had covered more than 4 decades. In the first of these decades, 54 bulletins were written, 49 in the second, 72 in the third, and 52 in the fourth. This showed a rather remarkable evenness in distribution of the amount of work (W-85).

Bulletin No. 1, dated November 10, 1887, by A. Keffer, was entitled, "Notes on the Growth of Trees in the Agricultural College Grounds" and showed how important trees were in those early days, not only in beautifying the barren prairies, but for fuel and shade as well. The last bulletin published before the division of Dakota Territory into South and North Dakota was number 15, printed in November 1889, also written by A. Keffer. The title is "Forestry" and it deals mainly with the same subject and gives a diagram of the college plantings. So important was the growing of trees in the state that Governor Arthur C. Mellette issued a proclamation on April 3, 1891, designating May 1 as Arbor Day. This was probably the first Arbor Day proclamation issued in the new state of South Dakota. "Teachers should take this occasion to impress upon the pupils the necessity of timber to civilization," said the governor (W-84).

In the earliest days it was not generally believed that trees could be grown successfully on the open prairies. Hence, Keffer placed special emphasis on experiments in tree-planting. Orchards containing apple, plum, cherry and pear trees were planted at the same time. The surviving trees were taken over as the college grove (W-87).

The grove was the site of many picnics and it sheltered the Poultry Department for about 40 years starting in 1925. It was partially replaced with housing for married students after World War II and finally entirely removed to make room for dormitories, a cafeteria and the new Student Union.

Keffer, who left South Dakota to become chief forester for the USDA, was succeeded by L. C. Corbett. After several years Corbett demonstrated that many vegetables could be successfully grown upon the open prairie, provided suitable varieties were chosen and the methods adapted to prairie conditions. He later became senior horticulturist for the USDA and was succeeded by N. E. Hansen in 1895 (W-87).

Hansen began originating fruits specially adapted to Dakota prairie conditions. In 35 years 600,000 fruit seedlings were grown, including apple, pear, crabapple, plum, sandcherry, grape and other small fruits. The native plum, sandcherry, apple, raspberry,

gooseberry, strawberry and grape were hybridized with cultivated species from other regions of the old and new world. Many of these fruits were extensively grown in the western states from Texas northward into Canada. Trees were sent to many foreign countries (W-88).

The work in hybridizing fruits was done chiefly in the fruit-breeding laboratory. In 1897 Dr. Hansen first devised the method of growing the wild and cultivated fruits in tubs so that the hybridizing could be carried on during the winter and early spring before the outdoor trees were in blossom. This method was widely used by other experiment stations. In 1931 South Dakota still had the largest tub orchard and the largest fruit-breeding laboratory in the world (W-88).

J. H. Shepard pioneered in the field of sugar beet improvement. He worked for a quarter century to develop sugar beets with higher sugar content. His experimentation became famous the world over as did his work in the new pure-food movement (W-89).

Horticulturists, botanists and agronomists tested many species of plants from the old world and from western states for adaptability to South Dakota conditions. Improved varieties, specially adapted to various areas of the state, were developed from species that gave the most promise of being useful to South Dakota farmers and ranchers.

Agronomists conducted long-term crop rotation and soil fertility studies and other crop and soil management experiments to determine the best methods of handling the crops and soils in the state.

With improved crops and better management of both crops and soils, agriculture was greatly stabilized.

By 1954 the departments of Agronomy, Plant Pathology and Horticulture discovered and developed new and better crops as well as better crop management practices.

A dozen varieties of small grain and eight corn, hybrids, bred and developed for South Dakota conditions, had been released to farmers (LAD-20).

Four sorghum varieties--two forage and two grain were also bred and developed at the Experiment Station. The two forage sorghums, 39-30-S and Rancher, were of particular importance because they contained very little prussic acid and were, therefore, not poisonous to livestock. The two grain sorghums, Norghum and Reliance, were not only adapted to South Dakota conditions, but were among the

first varieties developed for straight combining (LAD-20).

Several corn inbreds, resistant to root rot and other diseases, were developed. A strain of cottonwood trees--a male tree that did not produce "cotton" and which was highly resistant to leaf rust--was developed and released in 1954. It was expected to be a popular tree for use in shelterbelts (LAD-20).

Varieties of plums, apples, apricots and small fruits such as strawberries, tolerant of South Dakota winter weather, were released for general use. Sioux-ann and State Fair were two tomato varieties that were bred for South Dakota conditions, and a hardy Chinese elm was selected at the Experiment Station (LAD-20).

The study of soils, fertilizers, soil management practices and weed control methods yielded information which resulted in proper land use and efficient and sustained crop production when put into use. Basic soil surveys were completed in 15 counties. They furnished an inventory of soil resources as well as basic information for soil management and conservation (LAD-20).

Animal Sciences

The departments of Animal Husbandry, Dairy Husbandry, Poultry, and Veterinary Science were concerned with the improvement of livestock and livestock management (LAD-20).

Starting in 1909 the Veterinary Department produced hog cholera antiserum. This practice continued for several years, but was discontinued when production by commercial companies was sufficient to supply the demand (Cir 123).

In the Animal Husbandry Department, prior to 1930, nearly all the studies were made on feeds and feeding; important bulletins were published particularly on feeding pigs, sheep and cattle (W-85).

The propagation of Siberian fat-rumped sheep, imported by N. E. Hansen, was a project which received widespread comment. J. W. Wilson initiated the work in 1913 when Hansen brought four ewes and two rams of fat-rumped sheep found in Siberia. They were characterized by long and coarse hairy fleeces, fat rumps and no tails (Cir 123).

The breeding work attempted to develop a breed that would not have to be docked and still retain desirable mutton and wool qualities. Up until 1955 the tail length ranged from no tails to 4 to 5 inches. Wool density was insufficient and too variable and mutton quality could still be improved. Important

characteristics were hardiness, ability to rustle for feed and open face (Cir 123).

The program was discontinued during the late 1950s.

With the Dairy Department, the early bulletins dealt almost equally with feeding and with milk and its products. The department greatly promoted dairying and creamery work in the state (W-85).

During later years, breeding projects resulted in improved strains of cattle, sheep and hogs. Inbreeding and hybridization of chickens increased egg production and feed efficiency. The development of rapid-feathering strains of heavy breed chickens was an improvement in poultry brought about by breeding methods (LAD-20).

Research in the nutritional needs of the dairy and beef cattle and the mineral requirements of turkeys and chickens were very helpful in determining the proper rations for these animals. Studies on the feeding value of soft corn for cattle, sheep and hogs and the feeding value of sorghum grain for hogs and of small grain for all classes of livestock resulted in better utilization of these crops and more efficient livestock production (LAD-20).

Studies with native hay showed that it was more nutritious when cut at an early stage of growth than when cut at later stages of development. Grazing studies were conducted in which the summer grazing of beef cattle was correlated with calf crop, and efficient milk production was correlated with the type of pasture grazed by dairy cattle. The use of legume silage for dairy cattle resulted in more economical milk production (LAD-21).

Other nutritional studies of particular interest were the findings on the value of antibiotics and vitamin B₁₂ in breeding rations for poultry and swine and the value of antibiotics in sheep production. The toxic effect of selenium on turkeys and chickens was determined and a technique for preventing selenium poisoning in swine was developed (LAD-21).

Other management experiments included investigations concerning the returns from 1- and 2-litter systems of swine production and studies of milk handling and care of equipment in the dairy barn (LAD-21).

Much was done to improve the disease situation among the livestock on South Dakota farms. Perhaps the first marked success was the research on glanders of horses which led to eradicating the disease. Other areas of

study included internal parasites of sheep in range areas, the control of fowl cholera and current research dealing with sporadic bovine encephalitis (LAD-21).

Social Sciences

Research on problems which affected the people directly were conducted by the departments of Agricultural Economics, Rural Sociology and Home Economics.

In Agricultural Economics, research in farm business management helped South Dakota farmers improve the organization and operation of their farm businesses. Likewise, marketing studies of various commodities enabled farmers to adjust production processes to meet favorable seasonal trends. Marketing in cooperatives aided those organizations in improving their management practices. Recommendations improving public finance and taxation methods were provided for citizens and legislative committees (LAD-21).

Other studies included leases, leasing and other problems concerned with land economics such as economics of cropping practices and studies on the implications of irrigation and of weather. SDSC pioneered in the field of the economics of agricultural climatology (LAD-21).

The Rural Sociology Department conducted research on rural education which served as a basis for some of the school reorganization legislation in the 1950s. Other research was directed toward sociological problems of population changes, state organization, influence of government agencies on citizens, old-age assistance, rural relief and aid to dependent children. The department pioneered in studies on religious organizations (LAD-21).

In Home Economics, attention was directed toward the homemaker during the 1940s. Results from one research project helped many housewives utilize their time more efficiently. Results from another showed that the diets South Dakota women could be improved. Research on the service and quality of garments made of new wool with varying amounts of re-used wool were conducted, while the objective of another study was to determine the nutritive value and use of South Dakota-grown fruits and vegetables (LAD-21).

Other Departments

Three other departments were Station Biochemistry, Entomology and Agricultural Engineering.

The Station Biochemistry Department cooperated on many nutritional and other studies

described above.

It also helped South Dakota farmers with many chemical problems. The analysis of feeds for protein and mineral constituents and poisons and of water for mineral constituents was a valuable service to state citizens (LAD-21).

In research, selenium poisoning received much attention because of its importance within the state. Work on the problem demonstrated means of preventing the poisoning symptoms in laboratory animals and to some extent in farm animals, thus pointing the way to eventual prevention of the malady in seleniferous areas (LAD-22).

Other work on nitrate poisoning of ruminants indicated that carotene (provitamin A) losses in mixed feeds during storage could be largely controlled by proper feed formulation (LAD-22).

The Entomology Department conducted research on habits and methods of control of many insects. Life histories of a number of serious insect pests of animals and crops were studied under South Dakota conditions and the economic importance of these pests to the farmers was of primary concern. Entomologists were concerned with grasshoppers, cutworms, army worms, wireworms, plum tree borer, alfalfa insects and many others (LAD-22). Later corn borers, corn root worms, aphids, greenbugs and still others received considerable attention.

Surveys of the abundance of insects, such as grasshoppers and corn borers, made it possible to forecast the seriousness of the pests for the next year. Farmers could make preparations to control the pests in areas where there were enough insects to make the effort worthwhile for the farmers (LAD-22).

Research was also conducted on external and internal insect pests of livestock. Controls for cattle grubs, stable flies, horn flies, screw-worm flies, mites, lice and ticks were studied and attention was given the use of insecticides for control (LAD-22).

In Agricultural Engineering, research on farm structures led to the use of rammed earth for building farm buildings during the 1930s and 1940s. It also resulted in the use of shale from the West River area for the production of light weight aggregate used to make light weight cement blocks. Different types of silage structures and machinery were studied. In 1954 types of crop drying and processing equipment and methods of irrigation were being studied because these problems were becoming increasingly more important (LAD-22).

LATER ACHIEVEMENTS

Experiment Station circular 123 "Better Agriculture Through Research in South Dakota, 1887-1956" summarized the knowledge gained from research in 70 years. In 63 pages, it was only able to briefly describe the accomplishments in a very general way.

Obviously, it is impossible to summarize the accomplishments of the Experiment Station

that is reported in 675 bulletins, 56 technical bulletins and 232 circulars. In addition, many research results have been published in "Farm and Home Research," a publication that includes a half dozen reports in each of four issues for each volume. Volume XXXI was published in 1980.

Research findings in Agronomy are given in later chapters, however.



Campanile (1929), East Men's Hall (1920), Home Management House (1890), Woodbine Cottage (1887), Wecota (1915) and Wenona (1909) (Photo taken in 1931).



Clockwise: Campanile, East Men's Wecota, Wenona, Dairy (1899), Ag Engineering (1899), Gymnasium-Armory (1918), North (1887), Central (1884), Administration (1912 & 1918), Library (1927) (Photo in 1931).



Dairy, Ag Engineering, North, Central, Administration and Library (Photo from Pugsley in 1940).

CHAPTER XI COOPERATIVE EXTENSION SERVICE

The Cooperative Extension Service is a county-state-federal agency, and as such, its objectives and work are designed in the mutual interest of and to promote the welfare of all the people, particularly rural people.

The Smith-Lever Act prescribes a cooperative or mutual partnership between the state agricultural college and the U.S. Secretary of Agriculture in developing plans for carrying on Cooperative Extension. This partnership extends to the county level by which county Extension agents work with local people in developing plans based upon their needs and interests.

State, county, college, or local authority, or individuals can contribute to the state's offset funds required by the Smith-Lever and subsequent acts for the maintenance of Cooperative Extension work.

The scope of Cooperative Agricultural Extension work covers the entire rural field, including economic production, economic marketing and the development of better home, community and social conditions.

The work of the Extension Service is educational and its chief function is to help people help themselves through teaching, technical advice and leadership opportunities.

Since 1914, off-campus adult education in agriculture and home economics has been conducted under the auspices of the Cooperative Extension Service.

The information in this chapter was taken from the 1924 annual report by W. F. Kumlien, the last half of Chapter VI (written by A. E. Anderson) of a history edited by William H. Powers in 1931 and a mimeographed historical report compiled by Lyle A. Derscheid in 1954. Sources are indicated by "WK", "A" or "LAD" and appropriate page number.

FARMERS' INSTITUTES

The Extension Service as an agency did not come into being until the Smith-Lever Act was passed in 1914, but Extension-type activities started as early as 1888. There were organized clubs of farmers. Programs were conducted using local talent, and topics of interest to farmers were fully discussed. These discussions developed into institutes (A-91).

Dakota Agricultural College began its farmers' institutes in 1888. Before the close of the fall term, President McLouth arranged

for an institute to be held immediately after the end of the term. It was also the end of the academic year. The institutes lasted from November 26 to December 14 and were attended by 45 farmers. Several members of the faculty delivered interesting and instructive lectures. Similarly, institutes were held at the agricultural college December 3 through 13, 1889 and November 17 through 21, 1890 (A-91).

In 1889 and in 1891 the State Legislature enacted laws providing assistance to farmers institutes but no money was appropriated until 1894.

The 1889 law provided for a district board of agriculture with the control of farmers' institutes placed in the hands of the board. Stacy Cochran was appointed director. At that time farmers in the state began to call on instructors at South Dakota Agricultural College for assistance in their institute programs (A-91).

In 1891 the board of trustees of South Dakota Agricultural College, with the approval of the regents of education, was authorized to appoint and hold farmers' institutes in various places throughout the state. Professor A. H. Wheaton was designated as institute director and members of the college faculty held themselves in readiness to assist at farmers' institutes as they were invited (A-91).

In 1894, \$1,000 was appropriated for farmers' institutes and irrigation. In 1900, \$2,000 was appropriated for farmers' institutes (A-92).

In 1900 M. F. Greeley of Gary was appointed director of farmers' institutes, superseding Stacy Cochran, who had succeeded A. H. Wheaton (A-92).

The work was described in the report of the President of State College for the year ending June 30, 1901. "Different professors of agriculture were sent out to such communities as would arrange for a 3-day session and provide facilities necessary to conduct a successful institute (A-92).

The women of South Dakota also had a part in the farmers' institutes from the very first. Women speakers, discussing topics especially of interest to the home, were listed on the institute programs as early as 1886. Later the women began to exhibit bread and other products of the home and requested the farmers' institute director to send them someone who would be competent to judge such exhibits. This

resulted first in a general lecture on home economics on the institute program, then in separate meetings for the women with a definite organization called the Women's Auxiliary of the Farmers' Institute (A-97).

A. E. Chamberlain of Howard took Greeley's place in 1906. The legislature of 1905 appropriated \$5,000 annually for the institute. With further increased appropriations during the years 1908 and 1912, attendance and interest grew materially. The work gradually assumed the nature of local short courses in agriculture and home economics. Dr. H. H. Stoner of Highmore followed in the supervision of the work, continuing until July 1916. His successor, H. E. Dawes, developed some Extension correspondence courses in agriculture which were later discontinued. The day of the farmers' institute came to a close with the passage of the Smith-Lever Act (A-92).

Out of the farmers' institute developed a conscious need for more help in helping solve farmers' problems. They were especially concerned about crop diseases and insects as well as animal diseases, especially hog cholera. From 1908 to 1911 Dr. Seaman Knapp, who conducted demonstrations in Texas and Louisiana on controlling cotton boll weevil, attracted nation-wide attention. Businessmen's organizations, bankers' conventions and education associations were endorsing the work and discussing the possibility of having demonstration agents in their communities (WK-4).

At the same time, 1908 to 1912, the Roosevelt County Life Commission attracted much publicity. It called attention to the unequal development of rural life compared to urban life and stressed the inadequate opportunities existing in rural areas (WK-5).

The U.S. Department of Agriculture, through its farm management section, offered \$1,200 a year in federal aid to a limited number of counties that met certain requirements in employing a farm demonstration agent (WK-5).

Congress was also getting enthusiastic over the possibilities of farmers' demonstration work. Congressmen and senators from at least ten different states were vying with each other to introduce a bill that would meet with the approval of their respective bodies in granting federal aid for this work. No less than 17 different bills were introduced between 1909 and 1915 when the Smith-Lever bill finally became a law. Probably no important agricultural measure was ever passed by Congress which met with more favorable comment from all classes of people than the Smith Lever Law (WK-5).

In the meantime some of the forward looking men of our own state were beginning to wonder

if something could not be done for South Dakota. To Isaac Lincoln of Aberdeen, Z. I. Crain of Redfield and Lee Stover of Watertown belong the credit for taking the initiative in getting the first three agents placed. Correspondence in each of their offices showed that considerable correspondence was necessary before action was secured in any one of the three counties concerned (WK-6).

FIRST COUNTY AGENTS

Agricultural Extension work in South Dakota began in Brown County in March 1912. Farmers, businessmen, a railroad, Sears Roebuck and Co. and the county commissioners of Brown County made fiscal contributions and formed the Better Farming Association. This organization took the initiative in promoting and inaugurating county agent work and employed H. F. Patterson (WK-6).

He was appointed under a cooperative agreement between the Better Farming Association, USDA and SDSC. Part of his salary was paid by the National Harvester company (A-93).

In October 1912 the College issued a bulletin announcing correspondence courses of home studies. The first paragraph was headed: "Education-Experimentation-Extension," and contained the following sentence. "A third line of work--that of agricultural extension--is now starting." Dr. A. A. Brigham was first on the list of instructors (A-92).

On January 1, 1913, additional counties took up the county agent work, namely Codington County with A. W. Palm of Watertown as county agent, and Spink County with John Larson of Redfield as county agent (WK-6).

In Spink County, 341 farmers and several businessmen each contributed \$1.00 to the budget. The railroad also contributed and the County Commission added \$500. Individual memberships of \$10.00 were obtained from farmers and businessmen in Codington County. County Commissioners gave more support than in either Brown or Spink Counties (WK-6).

The USDA contributed \$1,200 towards the salary of each of the three agents, but felt that someone at SDSC should supervise the work and solicit reports. Dr. A. N. Hume, Agronomist at State College, was appointed as the first county agent leader in South Dakota, and carried on this work in addition to his regular duties until 1915 (A-93 and WK-6).

In 1913 W. M. Muir was employed as superintendent of boys' and girls' club work which was done in connection with the schools where clubs were organized mainly in corn growing, pig raising, gardening and canning (WK-7).

During the dry years of 1911 and 1913 deep tillage for moisture conservation was agitated by many. The distress and alarm caused by these 2 bad years in the wheat belt of the state probably did more to precipitate the selection of the first three county agents than any other one thing (WK-5).

By 1914 there were 843 county agents and 349 home demonstration agents in the U.S. Most of the women were working half-time with youth clubs (WK-6).

SMITH-LEVER ACT

The cooperative aspects of the Smith-Lever Act were unique. It was the first of many laws to provide for cooperation between federal and state governments. It also contemplated further cooperation between counties, local governments, various associations and individuals. Though farmers' institutes called attention to the need for disseminating information in oral and written form, Dr. Knapp's work in the South showed the value of demonstrations and was largely responsible for the emphasis on this type of Extension (WK-7).

Congressman Lever, co-author of the Act, said in a speech on the floor of the House while the bill was still pending, "We have accumulated in the agricultural colleges and in the Department sufficient agricultural information, which, if made available to the farmers of this country and used by them, would make a complete and absolute revolution...in the social and economic financial conditions of the rural population. The great problem which we are up against now is to find the machinery by which we can link up the man on the farm with those various sources of information...This bill proposes to set up a system of general demonstration throughout the country, and the agent in the field of the department and the college is to be the mouthpiece through which this information will reach the people (WK-8).

"The plan proposed in this bill undertakes to do by personal contact, not by writing or by standing and telling him it is a better plan, but by going to his farm under his own soil and climatic conditions and demonstrating there that you have a better method..." (WK-8).

The law included the following provisions:

"Section 1. In order to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics, and to encourage the application of the same, those may be continued or inaugurated in connection with the college or colleges (Land Grant) in each State or Territory receiving, benefits of the

Act of Congress (Morrill Act) approved July 2, 1862 and of the Act of Congress approved August 13, 1890, agricultural extension work which shall be carried on in cooperation with the United States Department of Agriculture.

"Section 2. Cooperative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics and subjects related thereto to persons not attending or residing at said colleges in the several communities and imparting information on said subjects through demonstrations, publications and ...for the necessary printing and distribution of information in connection with the foregoing; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the... agricultural college or colleges or Territorial possession receiving the benefits of this Act."

In 1914 the Smith-Lever Act appropriated \$480,000 for the first year (\$10,000 for each state) with annual increases until it reached the amount of \$4,850,000.

In June 1914 the regents of South Dakota voted to employ a Director of Extension and two field agents with the \$10,000 (K-60). Acting President Brown signed a memorandum of agreement with the USDA which provided for contributions to Extension funds by the federal government, the state of South Dakota and local communities. State College contracted to maintain a Division of Extension, and the USDA agreed to provide a State's Relation Service to administer the funds and cooperate with Extension work. Either the College or the USDA could nullify this arrangement (S-46).

SOUTH DAKOTA'S EXTENSION LAW

In January 1915 a law was passed by the South Dakota Legislature accepting in full the provisions of the Smith-Lever Act. It provided for carrying on the work cooperatively with the USDA and recognized the agricultural college as the administrator of this law in South Dakota (WK-9).

The state law was drawn up more specifically than the federal act, and it specifically provided for both statewide workers and county extension agents. The South Dakota law also provided for a local cooperating agency within each county, the county Farm Bureau. Up until 1919 the county organization was called the County Agricultural Extension Association (WK-9).

South Dakota was one of four states that provided a voting clause where under certain

conditions the question of raising funds for Extension work within the county could be voted upon at general election (WK-9).

In 1915 the provision for farmers' institutes was absorbed into regular Extension work under the name of "short courses." Provisions were made for at least 3 days of short course work in each county of the state not employing a county agent (WK-9).

The South Dakota Extension law became operative July 1, 1915. At this time, there were six county agents on the job with a district agent placed in each one of three congressional districts (WK-9).

The main contribution of the state law was to bring the state into a cooperative relationship financially, making it possible to expand work much faster and to standardize the methods used. It also brought assistance to county agents with educational matter supplied by Extension specialists (WK-9).

EXTENSION SERVICE DIRECTORS

Dr. A. N. Hume	1913-1915
Pres. E. C. Perisho	1914-1915
Gordon W. Randlett	1915-1918
Christian Larsen	1918-1920

W. F. Kumlien	1920-1925
A. E. Anderson	1925-1931
Alfred M. Eberle	1933-1941
John V. Heppler	1941-1945
George I. Gilbertson	1945-1958

Dr. John T. Stone	1958-1971
Dr. Duane C. Acker	1971-1974
Dr. Orville J. Young	1971-1975
Dr. Hollis C. Hall	1976-

Dr. A. N. Hume, college Agronomist, was appointed in 1913 by the USDA as the first county agent leader and he served in that capacity until 1915 (Ext-4). Since acting President Brown had signed the memorandum of understanding with the USDA, it is probable that the new President E. C. Perisho served as director from July 1, 1914, until December 1915.

The first director of Extension was Gordon W. Randlett, who served from December 1915 to March 1, 1918. C. Larsen, head of the Dairy Department, succeeded him and served until December 1920. The next director was W. F. Kumlien, who left the position to become Head of the newly formed Department of Rural Sociology in 1925. A. E. Anderson served from September 1925 until 1931 (A-93).

A. M. Eberle became director in 1931. On January 1, 1940, he became Dean of Agriculture.

Although he wanted to retain the directorship of Extension, John V. Heppler was employed for the position in 1941. He resigned 4 years later and was replaced by George I. Gilbertson, Extension Entomologist, who held the position for 13 years until he retired. W. E. Dittmer, Extension supervisor, served as Acting Director for 5 months until Dr. John T. Stone filled the position (Ext-4).

There was considerable sentiment for the newly appointed Dean of Agriculture, O. G. Bentley, to serve as Director of Experiment Station and Director Extension service. However, Stone would not accept a position that did not carry the full responsibility and authority of a director. Dean Bentley, who had no Extension experience, yielded to Stone's wishes. Dittmer served as Associate Director from 1959 until he retired on June 30, 1962.

Dr. D. C. Acker, who replaced O. G. Bentley as Dean of Agriculture and Director of Experiment Station, wished to be Director of Extension and require subject matter specialists to report to Department Heads. Stone resisted until 1969. Two years later he resigned and Acker then became Director of Extension. He named Dr. J. O. Young, Head of Dairy Department, as Associate Director. Acker left the campus in 1974 and Young was named Director. Young left to become Director in his home state of Washington in early 1975. Dr. Hollis C. Hall became Associate Dean and Director of Extension in 1976.

EXTENSION SERVICE HEADQUARTERS

The headquarters of the county agent leader from 1913 to 1915 was undoubtedly in the Agronomy Department, which may have been officed in the newly finished Agriculture and Administration Building. The office of the director may have moved to the Old Extension Building during World War I.

Old South was moved from its original location to make room for the north half of the Administration Building, that was completed in 1918, and sometime later renamed Old Extension. Either before or during the 1930s almost all of the state staff was officed in that building.

The radio recording studio was moved from third floor to the second floor of North in 1951 to the basement of Scokey Hall in 1961 and back to Old Extension in 1976.

In the fall of 1952, after Agricultural Hall was completed, the Director and supervisors moved to the suite of offices in Room 152 on first floor of the building in close proximity to other administrative offices of the Agriculture Division. Most agriculture

specialists moved to areas occupied by departments of their subject matter specialty in 1952 or shortly thereafter.

The visual aids shop was moved from third floor to the basement of North in 1953, to a barracks that had been used for student housing in 1961, and to the basement of the old Municipal Hospital in 1971.

Most home economics specialists remained in Old Extension until they moved to the Home Economics and Nursing Building in 1970. The 4-H staff didn't move until 1976 when Scobey Hall was converted from a dormitory to an office building.

MODE OF OPERATION

At first much of the help which the county agent rendered was through personal contact. There were very few organized groups and personal contacts were used to secure cooperators. Office consultations were relatively few and the number of farm visits high. The few farm meetings were well attended (WK-11).

County agents conducted demonstrations on alfalfa growing, land drainage and corn varieties and they worked for the control of animal diseases such as hog cholera scourges, anthrax and blackleg and the control of insect pests such as grasshoppers and army worms (A-93). Practically no marketing work was undertaken until 1916 except conducting an exchange list for seeds and livestock until few shipping associations were started in 1916 and 1917 (WK-11).

The principal organization problem was to keep the county agricultural associations functioning. Though the membership fee in each county association was \$1.00 per year, the average county membership was only slightly over 50 (WK-11).

In August 1917 the Food Production Act was passed--a program for increased food production and food conservation. It also included funds to pay for salary and travel expenses of an emergency county agent in every agricultural county where a regular county agricultural agent was not already employed. The state or county was responsible for office expenses (WK-12).

During 1917-1918 emergency agents were employed. One task was to organize emergency Farm Bureaus. In order for membership fees to pay the county's share of the county agent's salary, it was decided that each county organization must have 250 members before a county agent would be placed in the county. A state-wide membership drive was conducted. Membership rose from 1,466 in 1917 to 11,676 in 1919.

The 1919 legislature amended the Extension law to read that thereafter the County Agricultural Extension Association would officially become known as the County Farm Bureau (WK-13).

In the year 1917-1918 while the Food Production Act was in force, there were 35 emergency agents in South Dakota counties--24 were discontinued following the war (WK-19).

In most counties, only one full-time county worker was employed, but eastern counties had taken on part-time women workers who worked both with adult women and with girls (WK-19).

During the 10-year period, 1915-1924, 24 counties voted on the question of county agent work in four general elections--11 voted favorably while 13 discontinued the work (WK-19).

The appropriation of \$10,000 from Smith-Lever sources in 1914 was much increased by the Copper-Ketcham Act of 1928 which specified that federal funds would be available only if the state made a corresponding appropriation.

During the 1920s other agricultural organizations began to challenge the intimate relationship with the Farm Bureau, which had the specific purpose of cooperating with Extension work. Their argument was that the county agent was a public servant and that it should not be part of his job to promote organizations which frequently espoused public policies of a controversial character. Finally, in 1935, the Farm Bureau ceased to be the official cooperating organization with Extension (S-47).

Economy drives induced by the vicissitudes of the business cycle during the 1920s and early 1930s consequently made the county agent's situation precarious. Shortage of money might cause farmers to feel that the agent was a luxury. Voting was eliminated in 1935, and county agents began to receive all of their salaries from federal and state funds (S-47).

The Bankhead Jones Act of 1935 was the third federal act that provided funds for the Extension Service.

EXTENSION STAFF

There were three county agents and a superintendent of boys' and girls' clubs and a county agent leader in 1913, however, when the Smith-Lever Act became effective in July 1915, there were six county agents with a district agent in each of the three congressional districts (WK-10).

Shortly after the enactment of the Smith-Lever Act, provision was made for Extension

specialists in agriculture and home economics who could give assistance to county, agricultural and home economics agents on special problems and who also could give service to farmers and farm women in the state. In April 1916, the first specialists were appointed which included G. Morrison in livestock production, W. Ostrander in farm management, Ralph L. Patty in agricultural engineering and F. McCall in horticulture, animal disease control and dairying (A-98).

Then there were 14 county agents 7 subject matter specialists, a part-time supervisor of short-courses, two club workers, and the Director of Extension (WK-12).

The federal Food Production Act was passed on August 17. It was a program for increased food production and conservation and provided funds for emergency county agents in counties that did not have an agent. Between August 1917 and May 1918, 35 emergency agents were employed (WK-23). Twenty-four were discontinued after the war (WK-19).

Additional home economics workers were placed in the field. Roberta McNeil was appointed Home Demonstration Leader, and by June 1, 1918, there were twelve home demonstration agents at work. Each agent had a district comprising four counties. When the emergency funds terminated July 1, 1919, only Brown and Clark Counties found it possible to retain the home demonstration agents (A-97).

In 1919 there were 36 county agents and 11 specialists and supervisors in agriculture but only two home agents and 1 leader in home economics. There were 4 state club leaders and 3 county club leaders for a total of 57 employees. The number grew steadily until 1922 when the 71 employees included 48 county agents and 14 supervisors and specialists in agriculture, three home agents and three specialists and supervisors in home economics and three state club leaders (WK-13).

During the agricultural depression of 1921-1924 several counties voted to discontinue Extension work. The number of employees dropped to 62 in 1924. Though the number of county agents decreased to 37, the number of home agents increased to six. The club staff dropped to one. There were two editors, a state supervising agent, the director and specialists in agricultural engineering, agronomy, animal diseases, clothing, dairy, entomology-horticulture, farm management, foods and nutrition, livestock improvement, poultry and rural organization and two farm management demonstrators (WK-13).

During the late 1920s there was widespread opposition to Extension. In 1927, for example,

the legislature reduced the appropriations and several counties did likewise. By 1928 only 32 county agents remained (Ext-12).

On July 1, 1930, there were 15 home extension agents serving 46 counties and 32 county agriculture agents (A-94).

A. E. Anderson was Director of Extension, V. D. Basart, district Extension agent, and R. O. Davies, assistant county agent leader. H. M. Jones was state 4-H leader. In 1930 he was assisted by May Kiethline, Beulah Rodgers and six district club agents. S. H. Beck was Extension editor (A-99).

The Extension History lists eleven specialists--R. E. Johnston, Agronomist; May Kiethline and Anita Andrews, Clothing Specialists; G. Heebink, Dairyman; H. D. McCullough, Farm Management Specialist; Mary Dolve and Susan Wilder, Food and Nutrition Specialists; Mary Covert, Home Economist; A. L. Ford, Horticulturist-Entomologist; O. J. Wisner, Poultryman; and G. S. Weaver, Veterinarian. The position of Animal Husbandman was apparently vacant from 1928 to 1930. The total number was about 70.

By the end of 1932 there were only 24 county agents and 14 home economists remaining on the staff. Eight more agents were voted out in the fall election of 1932. It was then that the state staff was reorganized and the Agricultural Adjustment Law went into effect, carrying with it Federal appropriations for State Extension workers. This became the turning point in the history of Extension.

All county agents were given Federal appointments and put on a Federal salary. This made county agents' jobs a good deal more permanent. The 1935 legislature passed an entirely new Extension law that eliminated the vote feature in the counties. No significant legislation concerning Extension work has been passed since that year.

In 1954 there were 92 employees in the counties and 50 in the state office at SDSC for a total of 142 people (LAD-23).

The administrative and supervisory group included the director, four county agent supervisors and a home economics leader. They were people trained in agriculture and home economics who were concerned with policy making, supervision of field workers and coordination of the Extension work. They spent much of their time training new field workers (LAD-23).

The editorial and visual aids group of six worked closely with subject matter specialists in getting timely information to the people. They supplied news stories to newspapers, radio

stations and other news carrying media. They also spent much time in publishing leaflets and circulars that were distributed to the people of the state. They produced photographs, charts, maps, models and other visual aids that county agents and specialists used to explain and demonstrate the material presented at meetings (LAD-23).

The five youth leaders included a state 4-H Leader, three assistants and a rural youth leader. They helped train the rural young people through the 4-H clubs and the rural youth organizations. The young people learned by doing. They carried out projects in all phases of agriculture and home economics. In 1954 there were 1162 4-H Clubs with 13,553 members and 22 rural youth groups with 850 members in South Dakota (LAD-23).

The 30 subject matter specialists were trained in various phases of agriculture and home economics. Four Agricultural Economists specialized in farm management, farm and home development and marketing; two Agricultural Engineers specialized in farm building, farm machinery, irrigation and rural electrification; six in Agronomy were concerned with crops, soils and weeds; and three in Animal Husbandry discussed cattle, sheep and swine. There were two specialists each in Horticulture-Forestry and Poultry and one specialist each in Dairy, Entomology and Veterinary. Among the women specialists there was one each in home furnishings, clothing, foods and nutrition and music (LAD-24).

The main function of the subject matter specialists was to gather information in their respective fields and make it available. They studied research information from the experiment stations and put it into a form which was readily usable (bulletins, leaflets, circulars, demonstrations, etc.) which was given to the county agriculture and home demonstration agents for their use in bringing the information to their clientele. In addition, these specialists assisted in many meetings throughout the state in which they presented the material personally, judged crop or livestock shows at 4-H achievement days and county fair and State Fair, and assisted county agents in conducting farm and home demonstrations (LAD-24).

The Extension field workers included 59 county agricultural agents, 6 assistants and 37 home demonstration agents located in 59 different counties. Field workers were paid from state and federal funds, but office space and funds for operating the office and other expenses, such as mileage, were provided by the counties. They worked closely with the county extension boards, (which were appointed

by the county commissioners and were composed of one county commissioner, three farmers and one other person, usually a homemaker) to plan programs that fit their particular counties (LAD-24).

County Extension workers worked with individuals, organizations (livestock and/or crop improvement associations, ladies' home extension clubs and 4-H and rural youth clubs), and personnel of local, state and federal agencies. They held many educational meetings on all phases of agriculture and home economics and conducted numerous demonstrations on adapted crop varieties, use of fertilizers, weedicides, insecticides, home appliances, shelterbelts, irrigation, livestock management, water systems, sewage disposal units and many other phases of agriculture and home economics (LAD-24).

By 1979 the staff had increased in size to include 13 on the administrative staff, 61 specialists and 134 county agents for a total of 208 employees.

The administrative staff included the Director, program and staff development coordinator, eight supervisors (four in agriculture and four in home economics), state 4-H leader, ag information editor and administrative assistant (accountant).

Of the 50 specialists, 13 were only part-time extension, leaving the equivalent of 46 full-time employees (FTE). Agricultural specialists included 10 in Plant Science (crops, soils, weeds, irrigation, diseases and insects); 13 (11.6 FTE) in Economics (marketing, farm management, public affairs and community resource development); seven (6.3 FTE) in Agricultural Engineering (farm machinery, farm structures, water resources and irrigation equipment); eight (7.5 FTE) in Animal Science (beef, swine, sheep, nutrition, range management and poultry); two in Horticulture-Forestry, one in Dairy Science and one in Veterinary Science. Nine of them are located at places other than SDSU--Rapid City and Pierre. There were six Home Economics specialists (housing, interior design, family management, clothing, nutrition and human development); seven in 4-H; five (4 FTE) editors and visual aid specialists; one Wildlife Specialist and one Natural Resource Specialist.

On the county staff there were 59 county agricultural agents and 11 assistants in 59 counties. There were 31 home economics agents in 27 counties and 33 area home economics agents each of which served more than one county.

In 1980 state appropriations to the Cooperative Extension Service were reduced \$350,000 or

approximately 20 FTE's. As requested by the appropriation committee, all cuts were made at the state level and affected virtually every program and activity of the organization (Heitland).

The Community Development Program was reduced nearly 50% (2.5 FTE), natural resources (2 FTE's); agriculture (4.5 FTE's) or 13.5% reduction; home economics (1 FTE) or 16.7% reduction; 4-H Youth (1.3 FTE's) or 16.2% reduction; administration (1 FTE) or 10% reduction and 7.2 FTE of secretarial and part-time positions. Early retirements, staff reorganization, decreasing the term of some positions (reducing a 12-month position to 9 or 10 months) and in a few instances terminations were necessary (Heitland).

Nancy Fletcher was the first female assistant county agent. She was Assistant County Extension Agent in Beadle County from February 15, 1977 to June 30, 1978. She resigned when she married a man who lived in Iowa. This was common practice for female Extension workers. Many home economics agents had left their positions when they married or when their spouses took employment at another location. Some of them returned to the Extension Service when a position became available at the new location.

In March 1981 Deb Nehl became the first female county extension agent. She was raised on a Perkins County ranch, and majored in Animal Science and Vocational Agriculture. She was living in Watauga, just a few pastures west of McIntosh, when the Corson County Agent's position became vacant. She applied for it and got it.

EDUCATIONAL PROGRAMS

At first, with only a few counties having agricultural agents, the specialists assisted in farmers' institutes and short courses, giving lectures and demonstrations. A number of the specialists were a large factor in the control and eradication of many animal diseases, insect pests and grasshopper ravages. The earlier work was often in the nature of service to individuals. As more county agents were employed and found problems of a technical nature proposed to them, they called for the assistance of the specialists. By 1930 a great part of the time of specialists was devoted to assisting the county agents in special problems or special projects in their counties (A-98).

The specialist service became more and more important as farmers and farm women asked for technical and economic information relative to problems arising in the state. The staff of specialists grew in accord with the demand for such services (A-98).

Specific subject matter programs were developed by the various specialists.

Programs conducted by Agronomy specialists are discussed in Chapter XXXVI. Other programs are briefly described in the 26-page "History of Extension". Space here does not permit a more detailed discussion of programs that do not pertain to Agronomy.

A discussion of the traveling exhibits, which were major efforts but only a small part of the overall Extension program, do indicate, however, that Extension was an active and effective organization.

EXTENSION TRAVELING SHOWS

The Extension Service sponsored nine traveling exhibits or shows--two were transported by train and seven by truck. The "Dairy Special" featured the world's champion dairy cow, College Belle Wayne. The train ran in 1915 and 1916 and did much to stimulate improvement of the dairy industry (A-99).

The "Alfalfa and Sweetclover Special" ran from January 8 to February 10, 1925. It was sponsored by the South Dakota Crop Improvement Association and several other farmer groups "to promote greater acreage and use of these crops as the most reliable permanent and productive source of feed for maintaining livestock on South Dakota farms under all conditions" (JW-31).

Extension Agronomist, Ralph E. Johnston, and Extension Dairyman, Horace M. Jones, played major roles in the development of the exhibit and conducting the tour.

Johnston promoted the use of both alfalfa and sweetclover in crop rotations as the best way of maintaining soil fertility. These legumes put organic matter and nitrogen in the soil which improved soil tilth and provided nitrogen for other crops.

The train made 76 stops in Eastern South Dakota, was visited by 49,395 people for an average of 650 per stop and did much to increase the use of alfalfa and sweetclover (JW-12).

Seven shows were transported by truck. Shows were held during the first two months of 1950, 1951, 1952, 1954, 1957, 1965 and 1966. Shows were planned for 1953 and 1956, but moving of the audio visual shop in 1952 and lack of funds in 1955-56 caused a cancellation of plans.

The purpose of each show was to take the Extension Service and South Dakota State to the people of the state. It gave the people

an opportunity to discuss problems with the Extension specialists and ask questions. Extension specialists were afforded an opportunity to learn about problems directly from farm people.

Preparing this type of exhibit was a large undertaking; it involved several thousand dollars plus the time of the specialists who travelled with it. Its promotion, therefore, was extensive so that people over a wide area were informed and encouraged to attend.

For each show an exhibit committee selected the theme and name for the show, designated the subject matter areas to be included in the booths and determined where the exhibit would be shown.

Extension specialists in the designated subject matter areas determined the topics to be featured in their respective booths and accompanied the booth on the tour. They submitted rough sketches of their ideas to Milo Potas, Visual Aids Specialist. Sketches included the wording for charts, details for models and explanations of other displays.

Potas designed the booths and lighting and built most of the models. He had help for lettering on some of the charts--George Buntley, soils cartographer in 1950 and perhaps 1951 and 1952, a commercial artist for a week in 1954, and James Campbell in 1957.

Photographers John Gerken (1950, 1951 and 1952) and Lee Sudlow (1954, 1957, 1965 and 1966) assembled and prepared colored photographs and slides and slide projectors for different booths. They also provided projectors for the movies that were shown as part of several of the shows.

During the early 1950s the audio visual shop was located on the third floor of Old Extension Building. Raw materials were carried up and finished products down three flights of stairs for the 1950 show. However, the shop equipment was moved to the Agronomy Seedhouse where the 1951 and 1952 exhibits were constructed. Then the shop was moved to the basement of North. The time required for moving precluded the building of a show for 1953, but exhibits for 1954 and 1957 were constructed at that location. However, North was dismantled and the shop was moved to a barracks that had been used for student housing, where the exhibits used in 1965 and 1966 were erected.

A rented truck was used to transport the 1951 show, but a truck was purchased that summer. An enclosed box that The Sexauer Company no longer used for hauling seed was mounted on the truck, and "Big Red" was used

to transport six shows.

Each county had a sponsoring organization and an overall committee. The committee was responsible for local planning, organization and promotion of the show when scheduled for their area. For publicity they used news stories, suggested ads, slides for the theater and T.V. use, posters, badges and other materials provided by the Extension editorial staff.

The local group also arranged for a suitable place to hold the show. Specifications for 1957 were:

1. Floor space of about 40 by 80 feet on first floor, accessible for easy loading and unloading of exhibits; available from 8:30 a.m. to 5:00 p.m. on day of showing; electrical cable to carry 7,000 watts to selected spot.
2. Room in same or nearby building suitable for two or three showings of a film that accompanied the exhibits.
3. Arrange for help to clean the place before and after the showing and unload and load exhibits in truck. Provide two chairs for each booth.

At each location the county extension agent and local groups arranged for the use of the city auditorium, high school gymnasium, National Guard Armory or some other suitable facility. Visual Aid Specialists drove "Big Red" from town to town. They arrived at each location at 8:00 or 8:30 a.m. Local people helped unload the truck. Subject matter specialists arrived a few minutes later. Each specialist assembled his/her exhibit in the "horse-shoe" shaped arrangement of booths. The doors opened at 10:00 a.m. in some years and at 10:30 a.m. in others. The general public was admitted. At some locations the local people provided a food and drink concession because the show continued through the noon hour and until 4 p.m.

When the show closed for the day, the local people helped the Extension staff dismantle and load the exhibits. It usually took about an hour and the show participants moved to the next location where the process was repeated. Generally it was shown at four locations a week.

Few of the Extension staff attended all the showings during any one year. Generally two or three specialists took turns with each subject matter booth and supervisors alternated for the theme booth whenever there was one.

Farming in the Fifties

The 9-booth exhibit was scheduled for 27

showings in 25 counties--Beadle (2), Brown, Brookings, Brule, Davison, Dewey, Douglas, Edmunds, Fall River, Grant, Hamlin, Hanson, Lincoln, Lyman, McCook, Miner, Minnehaha, Pennington (2), Perkins, Roberts, Spink, Sully, Turner, Union and Yankton--during January and February of 1950. It concluded at Farm and Home Week on the campus of SDSC. A storm prevented the showing in Edmunds County.

Milo Potas accompanied the show on the entire tour to supervise the loading and unloading and tend to dozens of behind the scenes tasks. Attendance ranged from 254 at Elk Point to 1,927 at Milbank and 2,461 for two showings in Huron. Total attendance was 17,821 for an average of 685 at each of the 26 showings. Movies were shown at 22 locations with a total attendance of 4,525.

Such favorable reaction was received from visitors that the decision was made to sponsor a similar event the next year.

The *Extension Service Review* for June 1950 carried the following comments:

"Those who saw South Dakota's traveling exhibit liked it--liked its informative value, its interesting arrangement and its clever illustrations that showed clearly and concisely some of the answers to farmers' problems in a changing world. In fact, farmers and homemakers liked it so much that college president F. H. Leinbach received many letters commending its value.

"Farming in the 1950s was expertly prepared ...Its bulletlike presentation was aimed at promoting greater diversification in South Dakota farming, especially in the light of about 25% reduction in corn and wheat acreage and the need for an effective grassland agriculture to better maintain fertility of the soil.

"The exhibit graphically suggested how to obtain the goals of increasing the acreage of feed crops, alfalfa, sweetclover, soybeans, tame grasses and the like.

"In every county it attracted large crowds--this despite the below-zero weather and, in some instances, icy blizzards...The 9-panel exhibit covered such subjects as crops, soil management, livestock feeding, dairy, poultry, weed control and corn borers and was designed to promote questions by persons who viewed it.

"On the tour 24 counties were covered (26 showings) from January 20 to March 3. The strenuous schedule was strictly adhered to. Only 1 day was missed. The 1- and 2-day showings, erecting and dismantling the ex-

hibits, and traveling at night was a very tough assignment but specialists and agents said it was worth it."

Family Farming

Ten subject matter exhibits operated by Extension specialists and a theme booth manned by Extension supervisors were included in the 1951 show. It was displayed in 39 counties--Aurora, Beadle, Brown, Bon Homme, Brookings, Butte, Charles Mix, Clark, Clay, Codington, Corson, Custer, Davison, Day, Deuel, Edmunds, Grant, Haakon, Hamlin, Hand, Hughes, Hutchinson, Jerauld, Kingsbury, Lake, Lawrence, Lincoln, McCook, Marshall, Miner, Minnehaha, Moody, Perkins, Roberts, Sandborn, Tripp, Turner, Walworth and Yankton.

The title "Family Farming" proved to be a very good and popular one among the people of the state. It was of particular interest to women because fine exhibits were of special interest to the homemaker.

Though Milo Potas constructed the 11 exhibits, illness prevented him from attending the showings. John Gerkan, another Visual Aids Specialist, made the tour. Attendance ranged from 170 at Philip and 221 at Spearfish, both low population counties, to 2,094 at Webster and 2,161 at Watertown. Total attendance was 33,478 for an average of 858 at each location. Attendance was 11,920 at the movies which were shown as part of 36 of the displays. With a turnout like that, there is little wonder that plans were initiated to hold another show the following year.

Fortified Farming

Eleven subject matter exhibits and the theme booth emphasized the need for efficiency in production in 1952. The show was scheduled for 26 days in 25 counties--Beadle, Brown, Bennett, Bon Homme, Brule, Corson, Davison, Day, Deuel, Douglas, Fall River, Gregory, Hutchinson, Hyde (2), Kingsbury, Lake, Lyman, McCook, Meade, Minnehaha, Potter, Roberts, Spink, Turner and Union.

Some felt that the overall quality of the exhibits was better than for either of the two previous shows. There were more and better visual aids. However, the weatherman did not cooperate fully and blizzard conditions forced the cancellation of seven showings--Aberdeen, Lemmon, Hutchison, Hyde (2), McCook, and Gettysburg.

Attendance ranged from 155 at Sturgis and 179 at Madison, during snow storms, and 200 to 300 each at Chamberlain, Presho and Minnehaha to 1,324 at Webster and 1,468 at Huron for a total of 11,848, an average of 623 at each

showing. Movies shown at 17 of the towns attracted 4,115 viewers.

Plans were initiated for another exhibit the next year, but Milo Potas was moving his shop and did not have the time to prepare another set of exhibits.

Better Farming--Better Living

Ten subject matter booths and one central theme booth made up the show for 1954. It appeared in 25 counties--Brown, Charles Mix, Clark, Corson, Davison, Faulk, Grant, Gregory, Harding, Hutchinson, Hyde, Lake, Lincoln, McCook, McPherson, Marshall, Meade, Pennington, Perkins, Potter, Roberts, Sanborn, Tripp and Walworth. Movies were shown 43 times at 23 locations to 4,087 viewers.

This show was unique in that all five divisions--Agriculture, Engineering, General Science, Home Economics and Pharmacy had booths in it.

Blizzard conditions held attendance to 185 at Mobridge and 383 at Sturgis. At other locations attendance ranged from 191 at Buffalo and 255 at Rapid City to over 1,000 each at Huron, Lake Andes, Mitchell, Faulkton, Parkston, Leola and Britton. Total attendance was 18,204 for an average of 728 at each of 25 locations.

Family Farming For '57

The exhibit committee met in 1955 and made tentative plans to sponsor a show in 1956. However, due to lack of funds and limited time of Milo Potas and several other specialists, it was not possible to go to the field in 1956.

When the committee started work early in 1956 to plan and develop ideas for a traveling exhibit in 1957, the general idea of an overall show for farm and home development was to secure a well-balanced group of exhibits related to the business of farming and home-making.

The main objectives of the show were: to help the farmer and homemaker develop their resources, money and effort; to produce quality products that were in demand and yet be able to cut costs, save labor and material, increase profits; and to secure a more satisfying family living through improved farm and home practices.

When all exhibits were planned it appeared that "Family Farming For '57" would be a good title. The committee had expected more exhibits of interest to homemakers, but specialists in those areas failed to come forth with

an exhibit.

Potas designed the booths and fluorescent lighting. The booths were constructed by B and W Manufacturing Co. of Sioux Falls. Similar to the booths used in earlier shows, they consisted of two tables 3 feet high, 2 feet wide and 4 feet long which were spaced 2 feet apart and attached perpendicular to the background that was 8 feet wide and 7 feet high. The usable space consisted of the two tables and the upper 4 feet of the back.

Construction and painting of booths was greatly improved over previous years. They were more easily assembled, dismantled, loaded and unloaded.

Milo Potas built a large number of outstanding scale models accurate to the minutest detail, and developed several rotating or otherwise mobile exhibits requested by specialists. Lee Sudlow assembled and prepared colored pictures and slides for slide projectors which were used in some booths to present a story with a series of slides.

Sudlow's biggest responsibility was the key or theme booth--a 48-slide series with narration--which told the story of the Extension Service, Experiment Station and SDSC.

Practically all the material that went into the construction of booths was new. Much of the material from the old booths was used for the construction of boxes, frames and containers for transportation of models, projectors and a multitude of equipment and supplies for the show. Expenses for the construction and preparation of the show were \$4,134.98.

Titles for the 10 subject matter booths were:

1. The Modern Way to Better Hay--Ag. Engineering.
2. Making Farm Management and Marketing Decisions--Ag. Economics.
3. For Insect Control--Use Right Tool (Insecticide)--Entomology.
4. How Do You Manage (family resources)--Home Economics.
5. Keys to Successful Crop Production--Agronomy.
6. \$500 per Acre (home grown fruits and vegetables)--Horticulture and Home Ec.
7. Housing and Self-Feeding Dairy Cattle--Dairy.

8. Can You Lower Egg Production Costs--Poultry.
9. Getting The Most From Feeds--Animal Husbandry.
10. Can This year's Moisture Grow Next Years Crops?--Agronomy.

Jim Wilkerm was hired for 6 weeks to drive the truck. Milo Potas and Lee Sudlow alternated on the tour to take charge of loading, unloading and the showing of the movies.

The show appeared in 24 towns--Clear Lake, Sisseton, Webster and Lake Preston on January 15-18; Pierre, Gettysburg, Mobridge and Roscoe the week of January 22; Lemmon, Newell, Custer and Martin the week of January 29; Philip, Chamberlain, Miller and Redfield the first week of February; Winner, Armour, Mitchell and Parker February 12-15; and Dell Rapids, Bridgewater, Yankton and Howard during the week of February 19.

"The Agricultural Story", "the Rumen Story" and "Three Squares" were the titles of movies shown in rooms near the main show.

Viewers of the show said that it was the best of the five traveling exhibits in agricultural fields but that the show needed more exhibits for the homemaker.

Attendance at the main show ranged from 250 at Howard and 175 at Mobridge to 1,366 at Martin, but was within 150 of the 560 average at most other locations for a total of 13,421. The movies attracted 1,612 viewers for the 31 showings at 17 locations.

Surveys conducted during the spring of 1957 indicated that sentiment for continuing the exhibits was very high among county agents and their county leaders, however, 19 of 29 specialists voted for an exhibit in 3 or 5 years.

Farm and Home Show

Another traveling exhibit entitled "Farm and Home Show" went on the road during the winters of 1965 and 1966.

In 1965 the 11-booth show appeared in 17 cities--Woonsocket and Willow Lake, January 13 and 14; Britton, Eureka, Faulkton and Onida, the week of January 19; Hot Springs, Sturgis, Buffalo and Dupree the next week; Wall, Murdo, Mission and Wagner during the first week of February; and Centerville, Salem and Colman on February 9, 10 and 11.

A total of 5,050 people attended the exhibits with an average attendance of 297 at each location.

Because of the success of the 1965 show, it was repeated with few changes the following year. The 1966 Farm and Home Show appeared in 17 cities: Wilmot, Webster, Aberdeen and Arlington the week of January 17; Lemmon, Faith, Belle Fourche and Rapid City the week of January 24; Philip, Martin, Winner and Pierre during the third week; and Pierre, Mobridge, Miller, Plankinton and Tyndall the week of February 7 to 11. Attendance ranged from 120 on a stormy day at Pierre and 155 at Rapid City to 525 at Tyndall and 625 at Aberdeen for a total of 5,150--an average of 303 at each location.

Forty-three specialists and supervisors each spent at least one week attending an exhibit. The exhibits in 1966 were entitled:

1. Topsoil Management Insures Full Returns --proper use of fertilizer increases profit
2. Crops and Robbers - weeds, insects and plant diseases cost each farmer more than \$1,000 annually
3. Green Grass Gives Greater Grains--plant different pastures to grasses with different growing periods and graze each during the most productive period to get 6 to 7 months of grazing and higher gains
4. Education Pays--learning and earning go hand in hand
5. Developing our Resources--economic goals to be obtained by 1975
6. Opportunities for South Dakotans
7. Prepare for Rural Emergencies
8. Add Eggs in Place of Acres--bolster the family income
9. Wean More Pigs and Save more Lambs--a way of increasing profit
10. More Beef Per Acre and Beef Cattle Improvement - proper feeding, breeding and records are keys to better net returns
11. Dairy Production = Profit?--analyze your returns for labor

CHAPTER XII AGRICULTURE DIVISION

The Division of Agriculture was created in 1923. On March 15 the Board of Regents met at Aberdeen. Upon motion, the following specification of the duties of the Dean of Agriculture was passed: "The duties of the Dean of Agriculture shall be to have, under the direction of the President, general supervision of all agricultural activities at State College, in extension, experimentations, and instructions. His authorization shall be necessary for all agricultural expenditures--the employment of all instructors and employees, and the purchase of all agricultural equipment and supplies. He shall be the direct and active superintendent of all farming operations. He shall assign supervisory authority in the breeding, feeding and care of college herds to the agricultural faculty with a view to efficiency and economy. He shall make an annual report to the President of the college of all farming operations, the conditions of the herds, and make recommendations as for the succeeding year" (Regents Minutes).

The Dean's office was located in Room 212 on the second floor of the Agriculture and Administration Building (now called Administration Building). His office was at the top of the stairs in the south half of the building that was completed in 1913. In August 1952, the office was moved to the newly completed Agricultural Hall. It was located near the east entrance in a 5-room suite in room 154 where it remains at this writing.

The Dean of Agriculture had charge of resident instruction in agriculture which included college students and the School of Agriculture. It also included the livestock kept for instructional purposes. He took charge of Statewide Services which was created in 1923. He also had charge of the Farm Services which produced and processed much of the feed and forage needed for the raising of several classes of livestock.

Though the regents minutes specified that "his authorization shall be necessary for all agricultural expenses," federal regulations required the Directors of the Experiment Station and Extension Service to sign for the expenditure of all federal funds. Consequently, it appears that the Dean did not authorize the expenditure of Experiment Station funds until 1959 or the use of Extension monies until 1971.

DEANS OF AGRICULTURE

Christian Larsen, MSA	1923-1939
Alfred M. Eberle, MS	1940-1958
Dr. Ephriam Hixson	1954-1957
Dr. Orville G. Bentley	1958-1965

Dr. Duane C. Acker	1965-1974
Dr. Delwyn D. Dearborn	1974-
Dr. Raymond A. Moore	

The salary list of 1923-1924 shows that C. Larsen, MSA (Master of Science in Agriculture) had been appointed Dean on July 1, 1923 (K-68).

Larsen retired December 31, 1939. A. M. Eberle, who had been Director of Extension Service for 7 years, became Dean on January 1, 1940.

During the early 1950s, Jason S. Webster, who had been a full-time classroom instructor in Agronomy, started to work part-time in the Dean's office. He was concerned only with resident instruction of college students in agriculture. In 1956 he became a full-time Assistant to the Dean in charge of resident instruction.

The Board of Regents authorized the creation of a new position in 1953 with the title --Chief, Division of Agriculture. "The position will be comparable to an administrative vice president in charge of all agricultural activities. The new position will provide for continuity of planning for changes of personnel and the reorganization that will be developed as a result of personnel replacements" (K-116).

Dr. Ephriam Hixson of the University of Nebraska was selected as the new Chief, Division of Agriculture in July 1954. He was to begin work on September 1 (K-19). On April 16, 1957, President Headley relieved Hixson of his responsibilities and directed him to take over the Graduate Program. On August 28, 1957, Dr. Hixson submitted his resignation (K-122).

In January 1958 the Board of Regents established a Dean-Directorship for the Division of Agriculture (K-126), and Dean Eberle retired on June 30.

Dr. Orville G. Bentley became Dean of Agriculture on October 1, 1958. He took the titles of Dean of Agriculture, Director of Experiment Station and Director of Resident Instruction and selected Dr. John Stone as Director of Extension. Dr. Burton L. Brage was named became Assistant Director of Resident Instruction and Dr. A. L. Musson became Assistant to the Director of Experiment Station.

After Dean Bentley resigned in 1965 to become Dean and Director at the University of Illinois, Dr. Duane C. Acker assumed Bentley's titles and responsibilities in February 1966. During his

tenure, Brage and Musson became Associate Directors. Stone resigned in 1971 and Dean Acker took the title of Director of Extension.

In 1974 Acker resigned to become Chancellor of Agriculture at the University of Nebraska. His successor, Dr. Delwyn D. Dearborn, named Brage, Young and Moore (Musson's successor) as Directors of Resident Instruction, Extension and Experiment Station in 1974. A year later their titles were changed to Associate Dean and Director.

NAME CHANGE

In 1964 when the name of the college was changed to South Dakota State University, the Division of Agriculture became the College of Agriculture and Biological Sciences.

DEPARTMENTS

As a general rule, the departments in the Agricultural Experiment Station and the Agriculture Division were the same. However, there were some differences.

Station Biochemistry was a department in the Experiment Station from the beginning. It was not a teaching department and did not become a part of the Agriculture Division until 1958 when the Experiment Station actually became a part of the Division.

In contrast, the School of Agriculture, Farm Services and Statewide Services did no research. Consequently, they were not a part of the Experiment Station but became a part of the Agriculture Division when it was organized in 1923.

Other departments, whose resident teaching responsibilities came under the jurisdiction of the Agriculture Division in 1923 included Agronomy, Animal Husbandry, Dairy, Horticulture and Veterinary. It also included Poultry which became a teaching department in 1917 (S-44), but did not engage in research until 1925 (Cir 123).

Also in 1925, the departments of Agricultural Engineering, Farm Economics and Rural Sociology were organized. Like other departments, resident teaching functions were governed by the Division and research activities by the Experiment Station. Farm Economics was renamed Agricultural Economics. Later it was named Economics Department and some teaching was done in the Division of Arts and Sciences.

Home Economics research was done under the auspices of the Experiment Station beginning in 1926, but teaching came under the jurisdiction of the Division of Home Economics.

Research activities in Plant Pathology became a permanent part of the Experiment Station in 1940. Resident instruction was being handled by the Botany-Bacteriology-Pathology Department. It was part of the General Science Division until 1941 when the department was transferred to the Division of Agriculture (Regents minutes). Its name was shortened to Botany-Bacteriology in 1950 when some of its teaching responsibilities were transferred to the Plant Pathology Department. This Botany-Bacteriology Department rejoined the Experiment Station in 1961. A year later it was divided into the departments of Botany and Bacteriology. The Botany Department was renamed Botany-Biology in 1967 and Biology Department in 1979. The Bacteriology Department also was renamed. It became the Microbiology Department.

In 1953 resident instruction for Agricultural Engineering was transferred from the Agriculture Division to the Engineering Division (K-116). After the transfer, student enrollment in engineering exceeded that of agriculture for the first time in several years. Research activities continued under the auspices of the Agricultural Experiment Station and the curriculum for Mechanized Agriculture remained under the jurisdiction of the Division of Agriculture.

The Wildlife Department was formed in 1963 by separating the wildlife staff from the Entomology-Zoology Department.

The Animal Husbandry and Poultry Departments were merged July 1, 1967, forming the Animal Science Department. Two years later the departments of Agronomy and Plant Pathology were similarly merged to form the Plant Science Department.

On July 1, 1979, the Entomology-Zoology Department was dissolved. Entomologists were transferred to the Plant Science Department. Zoologists became members of the Department of Botany-Biology which was renamed Biology Department.

On July 1, 1980, the Agriculture Division included the Farm Services Department and Statewide Services and most of the departments in the Experiment Station--Agricultural Engineering, Animal Science, Biology, Dairy Science, Economics, Horticulture-Forestry, Microbiology, Plant Science, Rural Sociology, Veterinary Science, and Wildlife and Fisheries Sciences.

RESIDENT INSTRUCTION

The major responsibility of the Division was resident instruction both at the College level and in the School of Agriculture.

College

The Agriculture Division had the responsibility of training the great majority of the agricultural service personnel of the state, such as county agents, vocational agriculture high school teachers and veterans' instructors. Also, many such personnel as soil conservation service technicians, game and fish biologists, weed control supervisors, and State Department of Agriculture inspectors and analysts are agriculture graduates (LAD-2).

In addition, a great number of teachers and research people in the Agriculture Division received their undergraduate training at State College (LAD-2).

There was a steady increase in the percent of South Dakota farmers who had studied at State College. Industry and business were requesting more agricultural graduates every year. All parts of the world were anxious to get agricultural leadership from such schools as State College (LAD-2).

The Agriculture Division also acted as a service division for many students of other divisions. Many courses in botany, bacteriology, zoology, sociology and economics were taken by students outside the Agriculture Division (LAD-2).

School of Agriculture

The School of Agriculture was a department in the Division of Agriculture, organized to provide training in the less technical phases of agriculture for older rural youth who expected to engage in farming, ranching or related activities. Training was intensely practical with much of the instruction carried on in the barns, shops, laboratories and other college facilities. Instruction was of an advanced nature as compared to high school

agriculture and 4-H club work. A schedule of instruction for post-high school students was being stressed. Actually, the enrollees could be high school graduates, students who had some high school training or eighth grade graduates. The minimum entrance age was 16 years. A definite interest in agriculture was essential (LAD-2).

The schedule of instruction consisted of approximately 36 subjects offered in the departments of Animal Husbandry, Agronomy, Engineering, Agricultural Engineering, Veterinary Science, Dairy Husbandry, Agricultural Economics and the School of Agriculture itself. Extra-curricular activities included livestock judging, crops judging, music, basketball and debate. School opened the third week in October and closed the third week in March--a total of 20 weeks of instruction (LAD-2).

Over 90% of those who had attended were engaged in agriculture. Over 2,000 alumni and former students resided in South Dakota--an average of about 30 persons per county (LAD-12).

Graduates and former students contributed much to the betterment of agriculture in South Dakota. Most of them were successful breeders of livestock, producers of improved crops and, in general, good farmers and ranchers who were intensely loyal to State College and participated in many agricultural activities sponsored by SDSC or other agencies interested in an improved agriculture (LAD-3).

Approximately 6% of the School of Agriculture enrollees continued their education and completed degree courses, most in agriculture, but a few in other professions. Professions taken up by such persons included high school teaching, county agent work, college professors, military, lawyers and civil service work of one kind or another (LAD-3). The school was closed June 30, 1961 (K-54).



1973 Aerial View of Campus



1973 Aerial View of Campus

CHAPTER XIII EARLY BUILDINGS AND LAND

The histories by both Sewery and Kramer list the buildings built prior to 1955 and "Seventeen Years" lists those erected between 1958 and 1975. Neither publication discusses land acquisitions.

This chapter is concerned primarily with some of the details surrounding the construction, use and, in some cases, the demolition of the older buildings, a few buildings of particular importance to the Plant Science Department and larger parcels of land used by agriculture.

BUILDINGS

Records were not located on many of the temporary buildings that have long since disappeared, but some information about major buildings was obtained.

Central

The 1883 legislature appropriated \$20,000 for the "College Building" (K-27). Original plans called for an edifice with three parts, but only the south wing was built (S-12).



Northeast View of Central in 1962

On April 19, 1883, the directors that were appointed to oversee the construction of the building advertised for bids. On July 4, the building contract was awarded to a contractor from Mankato, Minnesota. There was a ground breaking ceremony the next day (S-12).

It was partly enclosed before winter. However, during the ensuing months snow drifted

into the basement, froze and packed so as to injure to foundation and walls (S-12). It was completed in 1884 in time for classes to begin on September 24 (S-13).

In the basement there were fuel and boiler rooms, janitors' rooms, an apparatus room, physical and chemical laboratories and a corridor running the full length of the building. On first floor was the main College office, the President's private office, matron's room, reception room, recitation room, chapel and a full-length corridor. Second floor contained the library and reading room, professors' room and three recitation rooms. The museum, drafting room, rooms for microscopy and botany were on third floor. There was a winding stairway from the basement to the top of the tower (S-65). A large room on third floor was used as a girls' dormitory for a few months in 1885.

Central was the main office building and acquired the name "Old Main." It became the home of the departments of Agricultural Economics, Rural Sociology and Printing and Rural Journalism before 1940--perhaps in 1925 when they were organized. Speech, organized at the same time, was in the building after World War II and may have been in it at an earlier date. The Student Bookstore and the *Industrial Collegian* were in the building until they moved to Pugsley Union in 1940. The Department of Animal Science moved to second floor during World War II. The post office and Printing-Rural Journalism Department moved to the Printing and Rural Journalism building in 1951 and the other (except Speech) departments moved to Agricultural Hall in 1952. During the next decade it was occupied by the Speech, Foreign Languages and perhaps other smaller departments. It was razed in 1962 to make room for Shepard Hall.

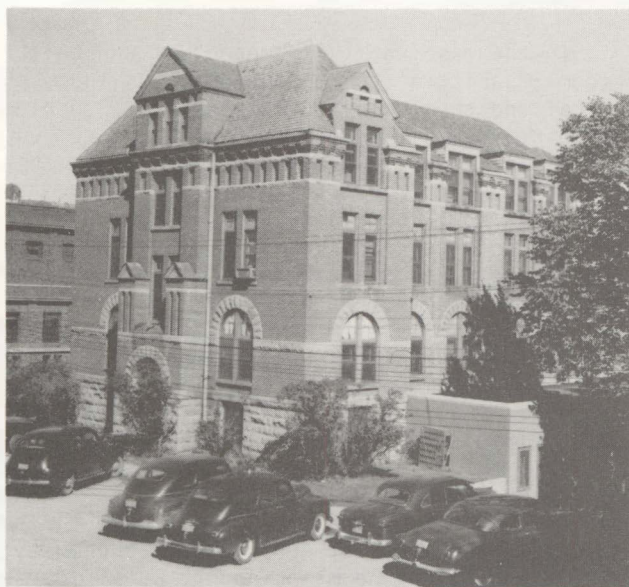
South

Built in 1885, it had three 3-room (study and two bedrooms for four students) suites on either side of a corridor on each of three floors with living and dining rooms, kitchen and laundry in the basement. Women students moved in on Thanksgiving day in 1885. Men began using it in 1887.

Prior to 1897 it was used for Experiment Station laboratories, botany and zoology. It was called "Station Building."

In 1918 it was moved 100 feet to the east, by rail, to make way for the north half of the Administration Building. It was remodeled and the Extension Service moved into it. Then it was renamed "Extension Building" and later "Old Extension".

A stuccoed 3-story addition was added to the east end and a "lean-to" to the south side. The "lean-to" housed the insect collection from 1935 to 1952 and was used as a music practice room in the 1960s and 1970s.



Southwest View of Old Extension (South) 1949.

The Extension radio recording studio and Extension audio-visual aids shop were moved to North in 1951 and 1953 respectively. Extension administration, many agricultural specialists, and most of the secretarial staff moved to Agricultural Hall in 1952; Home Economics specialists moved to the Home Economics and Nursing Building in 1969; and 4-H moved to Scobey Hall in 1976. The bulletin room was moved to basement from the Administration Building around 1950. It, the Agricultural Editorial Staff and News Bureau (renamed University Relations) occupied the building until 1981 when University Relations moved to the old classroom Annex.

North

In 1887 an appropriation of \$25,000 was made for a men's dormitory (K-35). Construction was completed in 1887, but the girls moved from South into the new structure (K-65). At first the girls occupied the upper two floors and the Chapel was on first floor. It housed the School of Agriculture most of the time from 1908 to 1961 (dormitory for a few years, offices and classrooms) and the printing laboratory from the late 1920s to 1951.

The Extension radio studio was on second floor from 1951 to 1961 and the Extension audio-visual aids shop in the basement from

1953 to 1961 along with the property room for dramatics. The clock in the tower was donated by the classes of 1922 and 1923. Men who brought their dates home (Wenona and Wecota) late complained that they didn't know what time it was (S-66). The building was dismantled in 1962 to make room for Shepard Hall.



South View of North in 1949.



Southeast View of Presidents Home in 1954.

Woodbine Cottage

President McClouth in 1887 built his own personal residence on the corner of Medary Avenue and 10th Street. He left in 1896. The next year a holding company composed of

Brookings citizens purchased the house to be used by the College (K-52). A few years later the state purchased it. For a time it was used as a women's dormitory and also for the Music Department. It became the home of the College President in 1903 and was used for that purpose until 1975 (K-35). President Briggs lived in it from July 1975 when he retired as President until he retired from active duty June 30, 1978. President Berg lived in privately owned quarters during that 3-year period, but moved into Woodbine Cottage when Briggs vacated it.

Home Management House

A wooden frame building was built across the street south from Woodbine Cottage in 1890 for use as a training laboratory in home management. Every 6 weeks a different group of about six home economics students lived in it. It was removed in 1980 to make room for a new Home Management House.

Electric Lighting

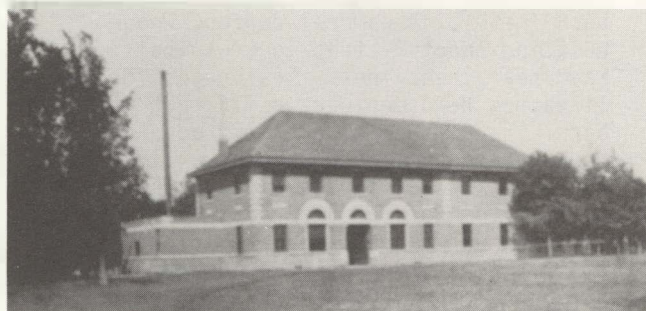
Electric lights were first used during commencement in 1896 (S-35).

First Chemistry Building

A brick building was erected behind Central in 1897. It was destroyed by fire in 1928. The second chemistry building was built a few yards farther north in 1929. Shepard Hall was attached to the west end of the second building in 1964.

Agricultural Building

The first of three Agricultural Buildings bears the inscription "Agricultural Building 1899" and is located immediately north of Agricultural Hall. Apparently it was used primarily for Dairy. Around the turn of the century it was referred to as "Dairy Building". Later it was known as the "Old Dairy Building" and graduates from the 1930s through the 1950s remember it as the

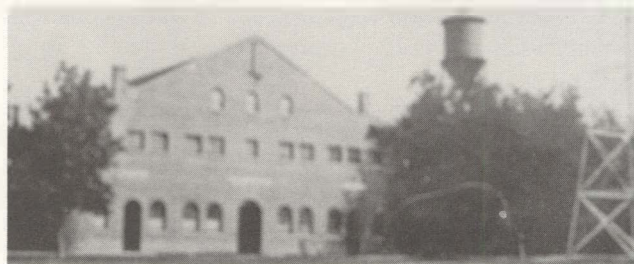


Southwest View of Agricultural Building in 1914.

source of large, delicious ice cream cones. The Dairy Department moved in 1962. A year later it was used for plant physiology research laboratories on first floor and the new Department of Wildlife on second floor. The physiology laboratories were moved to other quarters in 1971. The building now bears the sign "Wildlife and Fisheries Sciences."

Armory-Gymnasium

The first of three armories to be built during time of war was built directly east of the Agricultural Building in 1899. It was used as an armory until World War I (1918) when the "Barn" (second armory-gymnasium) was built. The first building housed Agricultural Engineering offices, classrooms and shops for many years before it burned on January 28, 1957. The area it occupied was then used as a parking lot for Agricultural Hall.



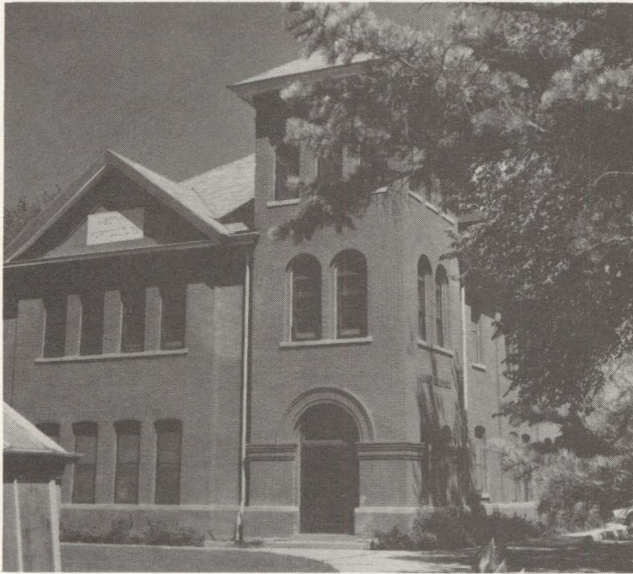
South View of Armory-Gymnasium in 1914.

Horticulture Building

Records show that an appropriation was made in 1901 for a plant breeding building (K-50) and that a headhouse was built in 1898 and a greenhouse in 1909. An old photograph shows that the headhouse-classroom, with a "lean to" greenhouse attached to the south side, was located 200 to 300 feet southwest of South.

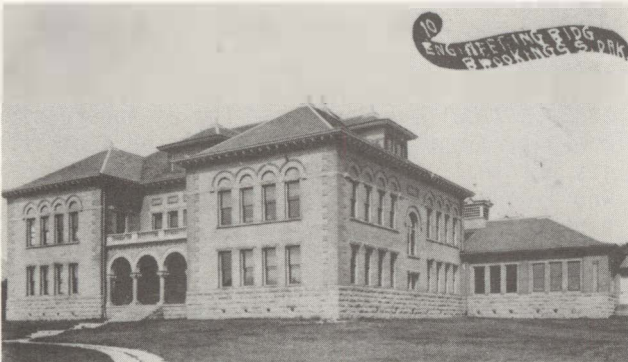
Another photograph of it appeared in the 1886-1887 College Catalog. It was apparently moved straight east a couple hundred feet from its original location. Dr. R. M. Peterson, who lived in Brookings prior to enrolling as a horticulture major in 1940, became a member of the faculty in the 1950s and Department Head in 1965, says that a larger greenhouse was attached to the headhouse at its new location prior to the construction of the Horticulture Building in 1901.

The Horticulture Building was located southeast of North and west of the headhouse. Later the Administration Building was built west of the Horticulture Building. One or two larger greenhouses were attached to the south side of the headhouse in 1909. The first one was removed during the late 1970s.



Southwest View of Horticulture Building in 1962.

The Horticulture-Forestry Department occupied the eastern portion of first floor. According to Peterson, N. E. Hansen said "I got the building and they gave me the keys to the back door, but I never got those for the front door". The Entomology-Zoology Department had a classroom on first floor and teaching laboratories and offices on second floor for many years. When it moved to Agricultural Hall in 1952, Horticulture Forestry had the entire building. However, most of the department moved to Agricultural Hall in 1977 and others moved to the new greenhouse-headhouse-teaching complex, located northeast of the Plant Science Building in 1980.



West View of Physics-Engineering Building in 1920s.

Physics and Engineering Building

In 1901 an appropriation of \$40,000 was made for an engineering building (K-50). Built south of the Horticulture Building it bears the inscription "Physics, Engineering 1901."

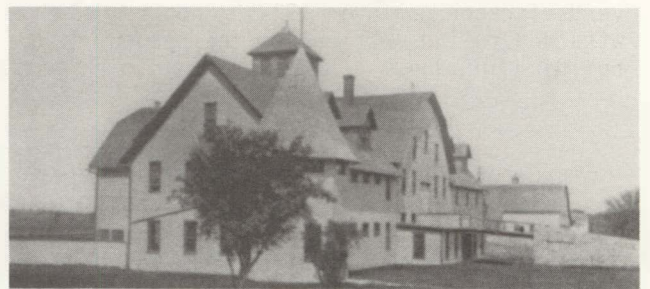
It was used for engineering offices, classrooms and shops until 1954 when the new Engineering Building (now Crothers Hall) was completed. The old building was renamed Solberg Hall in the early 1950s.



West View of Solberg Hall in 1971.

The roof was replaced in 1970. Engineering shops remained on the east half of the basement floor, and the remainder of the building was used by several departments during the next 25 years.

The Extension radio studio, college radio station, KESD and educational TV station, KESD-TV, were in the basement from about 1961 until 1976.



South View of Beef Barn in 1914.

Beef Barn

An appropriation was made in 1903 for a barn (K-50). A gambrel-roofed, wooden building about 80 feet long was built on West Farm near the campus. Residences for the livestock herdsman were built east of the barn. S. C. Salmon, a 1907 graduate, says he attended chemistry laboratory classes in the south end of the hay loft. The herds of Hereford, Angus and Shorthorn cattle used for teaching were kept in the building. It was dismantled in 1952 and the lumber used to build hog barns on the new swine unit. Starting in the 1960s the area once occupied by the barn was used as a parking lot for the Economics Department and for the motor pool.

Wenona Hall

The legislature in 1907 appropriated \$50,000 for a women's dormitory and specified that half the money should be spent each year of the biennium (K-50). It was built on the west side of Medary Avenue and helped form a circle of buildings around the college mall. It contained the President's dining hall, used for many organizational dinners for about 40 years, and was used as a women's dormitory. As a dormitory during the 1930s and early 1940s, it was used primarily by School of Agriculture girls and a few freshmen. From 1942 to 1946 it served as a barracks for servicemen stationed at SDSC. As enrollment grew it was used as a women's dorm until Pierson Hall was completed in 1965.



East View of Wenona Hall in 1970.

Since then it has had a variety of uses. Among them was the SDSC alumni office for several years prior to 1975 when Thompson Alumni Center was finished. The Heritage Museum was in the basement from the early 1960s until 1979 when it moved to the livestock Pavilion. Remote Sensing moved into the basement in 1979.

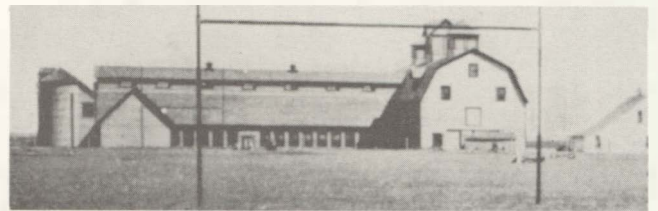
Dairy Barn

A 1891-92 photograph showed the Dairy buildings and farm buildings northwest of the intersection of Medary Avenue and 11th Street. In 1909 the legislature provided \$10,000 for a dairy barn (K-58). A building similar to the beef barn was erected northeast of the main campus on East Farm. Shortly after wards a house was built west of the barn to serve as

the residence for the dairy herdsmen. It was razed in 1971 and Briggs Library was built on the site in 1976.



South View of Dairy Barn in 1914.



Dairy Barn from football field (west) in 1914.

Agricultural and Administrative Building

An appropriation of \$100,000 was made for a building in 1911 (K-57). It was built in 1912 between South and the Physics and Engineering Building and immediately in front of the Horticulture Building. At first it housed agriculture and the College administrative offices. In 1917 the legislature appropriated \$100,000



West View of Administration Building in 1952.

to complete and equip Agricultural Hall (K-62). The north half of the building, called the Administration Building, was completed in 1918 (S-65). North was moved and the north wing of the Administration Building was built on the area formerly occupied by South.

For many years it housed the college administrative offices, the Division of Home Economics, the Division of Pharmacy, the administration and several departments in the Division of Agriculture and some departments in the Division of General Science. However, Agriculture moved out in 1952 and Home Economics moved in 1970. As the administration expanded, it occupied part of first floor and all of second floor. Pharmacy expanded into the area left vacant by Agriculture. Computer Services utilized the east wing of the first structure during the 1960s and 1970s.

Wecota Hall

An appropriation of \$75,000 was made in 1915 for a girl's dormitory (K-62). It joined Wenona Hall on the south. A year later a cafeteria was opened in the basement (S-65). Many students earned their board by working in the kitchen or dining room. It was closed in the mid-1960s, probably 1965 when Medary Commons was completed. Wecota Annex was added to the west side in 1940 (K-130).



East side of Wecota in 1962.

Both Wecota and Wenona were used as barracks for soldiers during World War II. Wecota was used as a dormitory for several years after Wenona was closed. In fact, it was frequently used for overflow for a few weeks during the fall semester as late as 1980.

Animal Health Laboratory

The first Veterinary Building, built prior to 1891 was near the first Dairy Buildings. Five thousand dollars was appropriated for an Animal Health Laboratory in 1917 (K-62). It was completed in 1920 and the Veterinary Building in 1922 (S-65).

The second building was located between the first two armories. After Veterinary moved to new quarters, range management personnel of the Animal Science Department officed in the building until 1976. Then members of the Biology Department officed in the building.

Heat Tunnels

The 1917 legislature appropriated \$15,000 to connect heating to on-campus buildings (K-62). The heat tunnels from the heating plant to other buildings were constructed in 1918.

East Men's Hall

Following World War I, the College took part in rehabilitation work for wounded and diseased soldiers for which it received partial reimbursement from the federal government (S-31).

There were 200 war wounded assigned to State College, but there was no dormitory to handle them. The Budget Board authorized \$53,000 for the project and the 1921 legislature appropriated \$55,565 (K-68). The building, first called Veteran's Hall (S-65), was constructed on the west side of Medary Avenue midway between 9th and 10th streets. It was ready for occupancy in 1920 (K-68) and was occupied in 1921 (S-65).

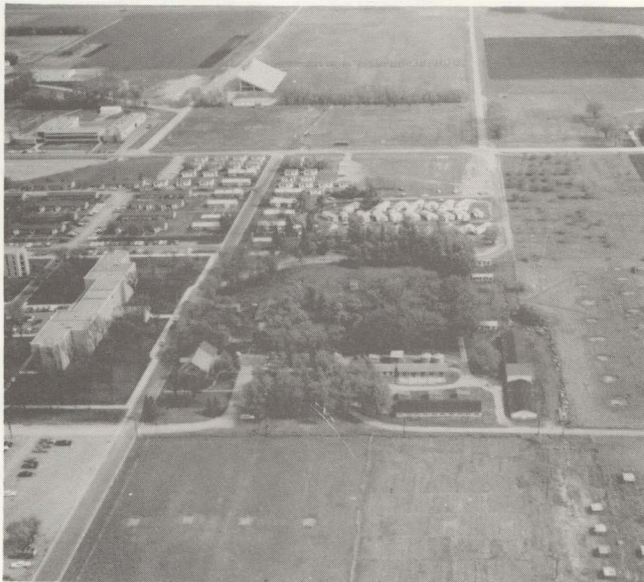


East side of East Men's Hall in 1962.

The vine-covered, stuccoed, 3-story frame building served as a dormitory until after World War II. After that it served for a variety of uses until 1977 when it was demolished. The site was converted to a parking lot for Thompson Alumni Center and Scobey Hall, which had been converted to an office building.

Poultry Buildings

The 1923 legislature appropriated \$8,000 to carry on poultry work (K-71) and the Poultry offices were completed in 1923 (K-130). The Poultry offices were built in the College Grove east of the main campus. Other buildings were built and pastures delineated. They were dismantled when the new Poultry Research Unit was completed in 1968. A year later Young Hall was built at the approximate location of the office building.



Poultry buildings, Mathews, Married student housing in 1967.

Horse Barn

The stone masonry building was constructed in 1925 (K-130). It was built with 2-horse stalls large enough to accommodate large Percherons with box stalls for stallions. It was used primarily for stabling horses used for teaching, but the Agronomy team occupied one stall. In the 1940s Percherons were replaced by light horses, two Morgan mares at first and Quarterhorses later on.

Lincoln Memorial Library

The library, named in honor of the President who signed the Morrill Act, was built in 1927 (S-66). A special session of the legislature, which convened from June 2 to July 1, 1925, designated that \$254,199 from the Cigarette

Tax Fund be used for the building (K-85).

The graduating classes of 1927 through 1930 provided funds for the construction of Sylvan Theatre immediately west of the library. Both the library and theatre were dedicated by U.S. President Coolidge on September 10, 1927.

Departments of English, Education and Mathematics were either wholly or partially officed in the building during the 1930s and 1940s. As enrollment enlarged and library demands increased, departments were moved.

The library was moved to Briggs Library in 1976 and was remodeled and assigned to the Music Department. The department, which had always had second-class accommodations, finally had excellent facilities.

Sylvan Theatre served as a beautiful setting for commencement exercises for many years until 1973 when they were moved to Frost Arena in the HPER building (Now Stanley J. Marshall HPER Building).

Campanile

The "trademark" for State College, the Campanile, was a gift from Charles Coughlin, a 1909 graduate. The cost was to range from \$15,000 to \$20,000 and it was to be located on a prominent part of the campus (K-79).

It was built in 1929 (S-66) for \$75,000 at the extreme southwest corner of the original tract of land purchased for the College--the southwest corner of the Mall. In 1960 a member of the landscape architecture class drew the specifications for the ornamental plantings near the structure.

Agricultural Hall

Appropriations by the legislature for Agricultural Hall included \$400,000 in 1947, \$400,000 in 1949 and \$125,000 in 1951 (K-102). The "L" shaped building was built at the north end of the College Mall and directly in front of the Agricultural Building built in 1899. The north-south leg of the "L" contained four floors while the rest of the building was only three stories high.

When the building was occupied in August 1952, three suites of offices near the east entrance on the main floor were used as administrative offices by the Dean of Agriculture, Director of Experiment Station and Director of Extension.

Rural Sociology was west of the administrative offices. Plant Pathology had a suite of offices at the north end of the main floor and Animal Husbandry occupied the remainder of the north wing.



South View of Agricultural Hall in 1952.

Agronomy and Agricultural Economics shared second floor, while Entomology-Zoology and Botany-Bacteriology shared third floor and Station Biochemistry utilized the basement floor.

Plant Pathology left its space at the north end of the main floor to Animal Husbandry in 1955. Animal Husbandry moved to the new Animal Science Building in 1976. The next year Horticulture-Forestry moved into the space with its main office where Plant Pathology was once.

In 1960 Agricultural Economics left part of its space to Rural Sociology. When Rural Sociology moved to Scobey Hall in 1976, the remainder of second floor was assigned to Plant Science.

Station Biochemistry was in the basement until 1975 when it moved to the Animal Science Building. Two years later the space was converted to a crops quality laboratory for Plant Science. In 1981 the Soil Testing Laboratory was also moved to the basement.

Development Hall

For years dormitory space was barely adequate. In 1939, for example, the enrollment was 1,376, and all the rooms in Wecota, Wenona and East Men's Hall were reserved when the writer arrived on campus a few days before registration. A year later, Scobey Hall for men and Wecota Annex for women were available, but enrollment had increased to 1,501.

After World War II, dormitory facilities

were woefully inadequate. Enrollment surpassed 2,000 in 1953. That year the State College Development Association erected a concrete block dormitory on the southwest corner of the intersection of 11th Street and 14th Avenue. Rental fees were used to repay the Association. It was called Development Hall.



North side of Development Hall in 1962.

The addition of Harding Hall in 1954 did not keep pace with enrollment which surpassed 3,000 in 1955-56. Brookings residents were asked to make a special effort to provide rooms for students.

In the mid-1950s, President Headley convinced the legislature that dormitories and cafeterias should be financed with revenue bonds to be retired with income from rental fees.

Since it was no longer necessary to rely on legislative appropriations, dormitories and cafeterias could be built as fast as the needs could be foreseen. Waneta Hall, Brown Hall and State Court were completed in 1959; Grove Commons and Mathews Hall in 1961; Pierson Hall and Medary Commons in 1965; Hansen Hall in 1967 and Binnewies Hall, Young Hall and Larsen Commons in 1969 (17 yr-19).

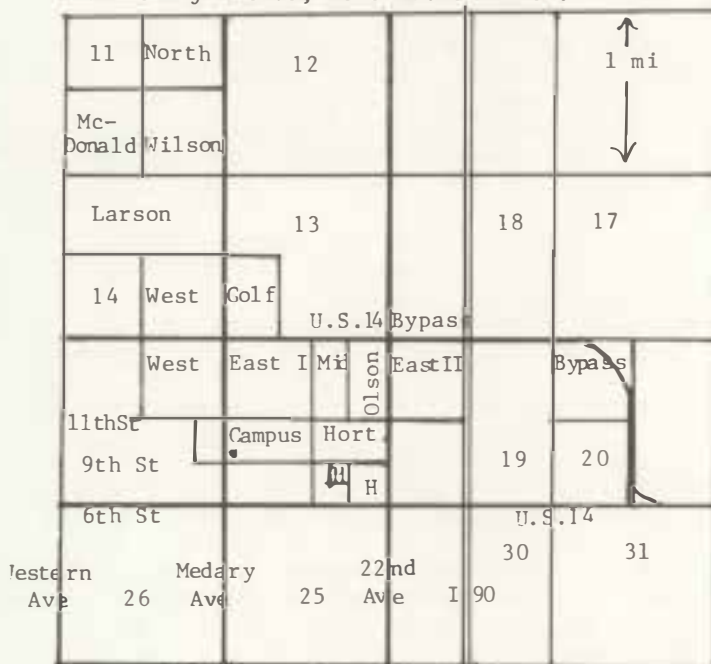
Development Hall was used as a men's dormitory for several years. However, as new facilities were completed it was not needed. It was converted to an office building for use by the English Department and perhaps others. A fire destroyed the building March 21, 1969.

The insurance money not needed to finish

paying for the cost of construction was donated to the College by the Development Association in 1971 and used for the construction of the field research building for the Horticulture Department on the Bypass Farm.

LAND ACQUISITIONS

Several large parcels of land were purchased. Information about them was obtained from the Brookings County Register of Deeds Office. Records for the smaller plots, such as those south of 9th street and those west of Medary Avenue, were not examined.



SDSU Campus and nearby farms

Main Campus

The Territorial Legislature Assembly of 1881 established the Agricultural College at Brookings provided that within one year a tract of 80 acres be donated to the territory. On August 20 and 21, 1881, the residents of Brookings collected \$600 and purchased 80 acres (S-11). The land (N1/2 of SW1/4 of Sec 24, T 11N, R 50W) belonged to Mrs. Randi Peterson and was bounded by Medary Avenue on the west, 16th Avenue on the east, 9th Street on the south and 11th Street on the north (K-14).

The area was occupied by the campus and horticultural plots. However, as the campus enlarged, buildings replaced plots. The entire area was finally used for buildings.

West Farm

The Territorial Legislature in 1887 autho-

rized the establishment of the Agricultural Experiment Station. It appropriated \$8,000 to purchase 320 acres for the Experiment Station (K-35). On July 25, 1887, two quarters (SE1/4 of Sec 14 and NE1/4 of Sec 23, T 11N, R 50W) were purchased from Ole A. Mork for \$7,900. It cornered the main campus and was on the west side of Medary Avenue (U.S. Highway 77) extending northward one mile from 11th Street. Though the two quarters were on different sections, they formed one contiguous unit until 1965 when they were separated by U.S. Highway 14 Bypass.

Agronomy West Farm was in the southwest corner of Section 14 for a half century, but most of the area was used for livestock. Various barns and sheds, the Livestock Pavilion (now Heritage Museum), the residence of the Dean of Agriculture, several houses, Hanson Hall and the motor pool occupied most of the southeast 40 acres in 1980.

East Farm I

The 1905 legislature appropriated funds to purchase a farm (K-50). One quarter (NW1/4 of Sec 24, T 11N, R 50W) was purchased on June 6, 1905, from Horace and Cornelius Fishback for \$17,000. It was north of the main campus on the east side of Medary extending 1/2 mile north from 11th Street.

The Dairy Barn was built on it in 1909 and much of it was used by the Dairy Department until 1970. Agronomy East Farm occupied the southwest corner until the early 1940s. The swine unit was north of the Agronomy East Farm until 1952. Part of the sheep unit was on it for many years.

In 1980 the southern two thirds was filled with buildings and athletic fields--track, football, baseball and intramural.

Horticulture Farm

Eighty acres (N1/2 of SE1/4 of Sec 24, T 11N, R 50W) were purchased for \$20,000 on March 22, 1919, from Alfred Soderling. It was used almost continuously by the Horticulture Department. During the 1950s, however, an 8-acre tract was used for weed control research by the Agronomy Department.

On June 4, 1935, the South Dakota Development Association purchased 40 acres (SE1/4 of SE1/4 of Sec 24, T 11N, R 50W) for \$2,000 from the Bank of Brookings. During the next 17 years, rental paid by SDSC paid for the land and it was deeded to State College on June 5, 1952. It was also used by the Horticulture Department. McCrory Gardens were planted on it in the 1967.

Another 10-acre tract (NW 1/4 of SW 1/4 of SE 1/4 of Sec 24, T 110N, R 50W) was purchased from Gladys Manbeck Hansen and Carl A. Hansen, the son the N. E. Hansen, for \$7,500 on April 11, 1932. It may have been used by the Poultry Department until 1971 when State Village, housing for married students, was built on it.

East Farm II

An appropriation of \$36,081.90 was made in 1919 by the legislature for the purchase of land (K-70). One quarter (NW 1/4 of Sec 19, T 110N, R 49W) was bought March 31, 1919, with a possession date of March 1, 1920, from John and Helen Raak. This quarter was one mile east of East Farm I and northeast of the intersection of 11th Street and 22nd Avenue.

East Farm II became the Horse Farm and headquarters for Farm Services. It produced pasture for the Percheron horses and feed for all classes of livestock until 1941. At that time the draft horses were sold and the Agronomy Farm moved to the north 140 acres. Another 15 acres were added to the Agronomy Farm in the mid-1950s.

About 25 acres were removed in 1965 when U.S. Highway 14 bypass was built along the north side and Interstate 29 along the east. The buildings continue to serve as field headquarters for Farm Services and as a residence for its foreman.

Mid-Farm

In 1929 the legislature appropriated \$19,500 for repairs and purchase of land. On May 10, 1929, an 80-acre tract (W 1/2 of NE 1/4 of Sec 24, T 110N, R 50W) was purchased from Cari and Christ Stevenson for \$12,800.

Mid-Farm bordered the eastern edge of East Farm I. Young dairy animals and dry cows were pastured and housed on the farm until about 1970. A Dairy Department or Farm Services employee lived in the house until the 1970s when it was removed. The Pharmacy Division kept their experimental animals in the barn. In 1980 at least 50 acres of it were used for the farmstead, football practice field, band practice area and Plant Science research plots.

Olson Eighty

On January 7, 1930, the State College Development Association, a newly organized group of Brookings residents, paid \$12,800 and signed an agreement with Callie Olson that allowed State College to use 80 acres of land (E 1/2 of NE 1/4 of Sec 24, T 110N, R 50W). Rent paid to the Development Association paid for

the land. For all practical purposes it belonged to the College, but title was still in the Olson name in 1980.

The Olson Eighty bordered Mid-Farm on the east and was across 22nd Avenue west from East Farm II. It was used for feed and forage production for many years. From 1951 to 1960 the east half was used for pasture research studies. After that it became part of the Agronomy Farm. The west half became the Plant Pathology Farm in 1955. In 1969 the entire 80 acres became part of the Plant Science Farm.

North Farm

State College paid the Rural Credit Board about \$10,000 for a quarter section (NE 1/4 of Sec 11, T 110N, R 50W) on November 2, 1937. The Rural Credit Board in 1936 had foreclosed on Albert Larkin, who had owned the farm for about 20 years, for a debt of \$10,129.13.

The farmstead was on the west side of U.S. Highway 77, 2 1/4 miles north of 11th Street. The house was the residence of a herdsman. It was used to produce livestock feed, and a swine unit was on the farm most of the time. The animal nutrition unit was moved there in 1967 from the area north of the Livestock Pavilion. Silos were erected and feeding facilities for beef and sheep constructed.

Agricultural Engineering Farm

The South Dakota Development Association on August 21, 1956, purchased 100 acres (N 1/2 of SW 1/4 and E 1/2 of SE 1/4 of SW 1/4 of Sec 15, T 109W, R 50W) from David R. and Ruth K. Flittie for \$15,000. The association deeded it to State University on July 16, 1969.

The farm was on the Sioux River bottom and the Agricultural Engineering Department used it for irrigation research. The Plant Science Department had research plots on it from time to time to evaluate different methods of establishing alfalfa stands, for example, or to evaluate promising new forage grass selections.

Larson Farm

The State College Development Association on March 1, 1950, purchased a half section (N 1/2 of Sec 14, T 110N, R 50W) for \$40,500 from T. J. Larson. It bordered the north edge of West Farm and extended one mile west from U.S. Highway 77.

The college used it for feed and forage production and paid rent. By March 12, 1963, the College had paid enough rent to repay the principal and interest and obtained title to the land. The house was the residence for a

Farm Service employee.

The Northern Grain Insect Laboratory was built on the northeast corner of the tract in 1961 and the poultry research unit 1/4 mile farther west in 1968. A boar testing station was built on the farmstead in the early 1960s and the wildlife storage unit in 1966. Beginning in the mid-1960s, the grass breeding plots were located west of the buildings. The buildings were removed in the mid-1970s.

Wilson Farm

State College bought a quarter (SE 1/4 of Sec 11, T 110N, R 50W) for \$50,000 on April 2, 1963, from the heirs of J. W. Wilson. Wilson had lived on the farm while serving as Experiment Station Director. This quarter was between the Larson Farm and North Farm. State College then owned all the land on the west side of U.S. Highway 77 for a stretch of 2 3/4 miles north from 9th Street.

The new Dairy Research and Production Unit was built on the Wilson Farm in 1970. For a time the foreman lived in the house acquired with the farm, but the house was replaced by a new one. Most of the farm was used by the Dairy Science Department for research and feed production. The new livestock feed unit was built on the southeast corner of the farm in the late 1970s.

Bypass Farm

Several acres of West Farm, East Farm I, Mid Farm, Olson Eighty and East Farm II were taken for right-of-way in 1965 when U.S. Highway 14 Bypass and Interstate 29 were constructed. The State Highway Department bought two quarters. One quarter (NW1/4 of Sec 20, T

110, R 49W) was purchased from D. N. McDonald for \$33,000 on October 5, 1965. It was 1 mile directly east of East Farm II. The Bypass ran along the north and east sides of the quarter and the curve cut off the northeast corner. The unused portion of the quarter was deeded to State University on February 28, 1966. It was assigned to the Horticulture-Forestry Department to replace the area lost by encroachment of the main campus. For several years grass breeding plots of the Plant Science Department occupied the northeast corner of the farm on the outside of the curve.

Moody County Farm

The second quarter (SE 1/4 of Sec 7, T 108N, R 49W) purchased in 1965 by the Highway Department was in Moody County, 11 miles south of the intersection of U.S. Highway 14 and I-29 on the east side of the Interstate. Soil from part of the area was used for highway construction. The Highway Department constructed a rest stop, using the barrow pit as a sewage lagoon, on the southwest corner of the tract. The remaining 117 acres were deeded to State University, probably on February 28, 1966. It was assigned to the Foundation Seed Stocks Division for the production of foundation seed of new crop varieties.

McDonald Farm

A quarter section (SW 1/4 Sec 11, T 110N, R 50W) was purchased for \$50,000 on December 12, 1974. It was obtained from Edna McDonald Sonnenberg, the daughter of Guy McDonald, a long-time staff member, and her husband E. E. Sonnenberg. It was located west of the Wilson Farm, and used by Farm Service and the Dairy Department.



Clockwise: Campanile (1929), East Men's (1920), Scobey (1940), Old City Hospital, Wecota Annex (1940), Wecota (1915), Wenona (1909), Agricultural Hall (1952), Ag Engineering (1899), Gym "Barn" (1918), Printing-Rural Journalism (1951), Armory (1942), Married Student Housing (1946), North (1887), Chemistry (1929), Storehouse and Power Plant, Central (1884), Administration (1912 & 1918), Old Extension (1884 moved in 1918), Horticulture (1901), Library (1927). (Photo 1954).

CHAPTER XIV DEPARTMENTAL FACILITIES

Facilities include offices for staff, laboratories for teaching and research, research farms and buildings and field and laboratory equipment.

OFFICES AND LABORATORIES

Entomology, was first taught with Botany which was located in Central. Later Entomology was transferred to the Station Building (originally called "South") and again, shortly after 1900, Entomology was transferred to the Horticulture Building. In 1920, when the departments of Zoology and Entomology were reunited, most courses for both disciplines were taught in the Horticulture Building. The insect collection was moved in 1935 to the Entomology Annex of the Extension Building (a structure used for music practice in the 1970s). A few taxonomy courses were taught there until 1952 (Balsbaugh).

Probably the Agriculturists were officed in Central and transferred to the Station Building during the 1890s. The soils laboratory was in Station Building and the first Agronomists may have officed there. The Agronomy Department may have moved to the Agriculture and Administration Building in 1912 when the south half of the building was completed or in 1918 when the north half was built. In 1939, when this writer arrived at SDSC, the Department occupied most of the south "L" of what was then the Administration Building.

Administration Building

The main office was in room 110. A door to the south opened into the Department Head's (A.N. Hume until Oct. 1943 and W.W. Worzella after that date) office, room 110A. A door to the east allowed access to room 108 where publications and departmental records were stored. Room 106 was a crops research laboratory with two attached smaller rooms. The west room, 106B, was the office of the small grain breeder and room 106A was used for storage of research material and laboratory equipment. S.P. Swenson occupied the office until he left and J. E. Grafius used the office for about a decade.

Room 104 was the Seed Laboratory, and room 102 was a class room. They were separated by another pair of offices. The east office, room 104A, opened into the Seed Laboratory and was the office of E. L. Erickson. The west office, room 102A, opened into the classroom and was used by C. J. Franzke.

A soils teaching laboratory, room 101, was on the east side of the hallway. A door to

the south opened into the Agronomy Greenhouse, a "lean to" attached to the south side of the Administration Building (photo page 33). Room 105 was a suite of four rooms. The vestibule, used for storage, opened into room 105A, a soil research laboratory; room 105B, L. F. Puhr's office; and room 105C, a larger room used as a laboratory and as an office by Edgar Joy.

In the east hallway, room 112 was a departmental storage room, and room 117 was a soil chemistry research laboratory with two small rooms attached to the east side. The room next to the window was the office of Ralph Arms; the other was a storage room for chemicals and laboratory equipment.

From 1944 to 1951, when many new staff members were employed, many changes were made. In 1944 the Seed Laboratory was moved to the second floor of the headhouse of the Horticulture Greenhouse. N. G. Patterson officed in the laboratory. A partition was built across the end of the south hall of the Administration Building to provide an office, room 100, for A. O. Syverud and G. D. Johnson.

Two offices were built across the west end of the former Seed Laboratory. Rooms 104A and 106A were removed, forming a small hall named the "Bowling Alley" along the east side of the two new offices and rooms 102A and 106B. All four offices opened into the Bowling Alley which was equipped with storage cabinets.

Rooms were renumbered, the offices of Franzke and Grafius became 104A and 104D. Erickson moved into 104B and Hume into 104C. Franzke shared his office with K. L. Manke in 1944. Two years later R. A. Cline replaced Joy and L. O. Fine moved into the office 117B. In 1947 Grafius shared his office with V. A. Dirs, Hume shared his with L. A. Derscheid, and J. G. Ross and M. W. Adams moved into the office vacated when Erickson resigned.

Cline shared his office with soil surveyors F. C. Westin in 1947, G. B. Lee and A. J. Klingelhoets a year or so later and F. E., Shubeck in 1951. In 1948 E. J. Williamson and P. L. Carson converted room 112 into the Soil Testing Laboratory, and Puhr shared his office with B. L. Brage in 1950.

Starting in 1940 the Plant Pathology office and laboratory were in room 119 of the Administration Building. W. L. Buchholtz was alone for 4 years but shared the space with C. M. Nagel from 1944 to 1946. After Buchholtz resigned, Nagel shared the space with others until 1952.

Agricultural Hall

In August 1952, the Agronomy Department moved to the second floor of Agricultural Hall where it occupied all of the north wing and the west half of the east wing. Plant Pathology moved to first floor where it had a suite of offices in rooms 102-108 and research laboratories across the hall in rooms 101 and 103 and a classroom. Entomology-Zoology moved to third floor where it had offices, teaching laboratories and class rooms in the east wing, and the insect collection in the north wing of the building.

The Agronomy main office was in room 219, between the offices of the Department Head, in room 217, and the Extension Agronomist, in room 221. Room 238 was a cartography laboratory for soil survey, rooms 240 and 242 were the Seed Laboratory and room 243 was a crops teaching laboratory. Rooms 223, 225 and perhaps a few others were offices.

Rooms 204-234 on the west side of the north wing were offices, while rooms on the east side were laboratories. Room 201 was a soils research laboratory; room 203, the Soil Testing Laboratory with an attached office; room 105 a soil teaching laboratory; and rooms 207, 209 and 211 were crops research laboratories. In most cases, staff members were officed across the hall from the laboratories in which they worked.

During the 1950s room 207 was used as a cytological and cytogenetic laboratory. Room 209 was used as a plant physiology research laboratory from 1956 to 1963 and as a soils research laboratory in the 1970s.

In 1955 Plant Pathology moved to the new office-laboratory-greenhouse complex. Shortly afterwards their former laboratory, room 101, became a soil physics laboratory.

The Dairy Department moved into its new building in 1962, and the first floor of the Old Dairy Building was used as offices and laboratories by plant physiologists in the Agronomy Department. They moved to the new Plant Physiology Annex to the Pathology complex in 1971. The enlarged complex became the Plant Science Building in 1971 or 1972.

More office space in the east wing of Agricultural Hall was assigned to the Agronomy Department in 1960. The Economics Department moved to the "Economics Shed" and the smaller incoming Sociology Department did not need all the space vacated.

Ag Biochemistry moved from the basement of Agricultural Hall to the new Animal Science Building in 1975. The basement was assigned

to the Plant Science Department in 1977 for use as a crop quality laboratory. Several plant breeders moved to the area. In 1981 the Soil Testing Laboratory was moved to the basement from second floor.

Sociology moved to Scobey Hall, which had been converted to an office building in 1976. Extension Entomologists moved into the suite of offices in rooms 246 and 248 in 1977. The remaining offices on second floor were also assigned to the Plant Science department.

Entomologists on the research and teaching staff moved to second floor of Agricultural Hall in July 1979. The Entomology teaching and research facilities and the insect collection remained on third floor but became part of the Plant Science Department on July 1, 1979.

AGRONOMY FARMS

Several areas were used for research on crops, soils and weed control.

Agronomy West Farm

Two quarters of land were bought for the Experiment Station in July 1887, and it seems likely that the Agronomy Farm was established on this land in 1888.

Luther Foster described the land used in 1888 for corn plots as being a sandy loam with a subsoil of clay and sloping to the northwest. It had been plowed in August 1887 (Bul 9). Two years later he described the land used for small grain plots in 1890 in the same manner and named the crops grown since 1886 (Bul 11) indicating that the same area had been used for plot work for several years.

E. C. Chilcott probably established his crop rotation experiments in the same area in 1897. He indicated that the uniform soil was a sandy loam that had produced several uniform crops of corn, oats and wheat. Photographs of the plots, taken in 1900, showed the college buildings in the background and indicated that the field was northwest of the campus on the north side of 11th Street (Bul 79).



First Agronomy Experiment (Photo in 1901).

The 8 1/2-acre field was divided into five series of plots separated by an alley that was kept free of vegetation by cultivation. Each series contained fourteen 1/10-acre plots two chains (8 rods) long and 50 links (2 rods) wide. The photos indicated that the long axis of plots was in an east-west direction; so, the long axis of each series would have been north and south. The field was probably about 28 rods wide from north to south and 48 rods long.

A. N. Hume used the term "West Farm" and indicated that part of it was in meadow until it was plowed in 1909 (Bul 151). West Farm was probably all or part of the NE 1/4 of Sec 23, which lay northwest of the intersection of 11th Street and Medary Avenue, and was purchased in 1887.

Franzke and Hume indicated that "Agronomy West Farm" was in existence in 1926 (Bul 305-28). It is not certain whether this name was used to distinguish it from "Agronomy East Farm" or to separate the area used by the Agronomy Department on "West Farm" from other areas on that Farm.

In 1939 when this writer arrived on the scene, Agronomy West Farm occupied the southwest 30 to 40 acres of the NE 1/4 of Sec 23. It was north of 11th Street, and the entrance, located at the southeast corner of the farm, was about 2 blocks west of Medary Avenue. The new beef barn was built near the northern side of this farm in 1951, and the remainder of the area used for pasture.

Agronomy East Farm

J. G. Hutton reported that he initiated a soil fertility experiment on "East Farm" in 1912 (Bul 325). East Farm was all or part of the NW 1/4 of Sec 24, which lay northeast of the intersection of 11th Street and Medary Avenue, and was purchased in 1905. However, in the 1930s "East Farm" was one mile farther east, the NW 1/4 of Sec 19.

Franzke and Hume indicated that "Agronomy East Farm" was in existence as early as 1929 (Bul 305). In 1939 Agronomy East Farm included about 40 acres in the SW 1/4 of NW 1/4 of Sec 24. It was located north of the stadium (Sexauer Field). The area was later used for the location of the new Agronomy Seedhouse, Agronomy Greenhouse, Plant Pathology Complex and the Animal Health Building. Perimeter Drive was built close to the northern boundary of the farm.

Agronomy Farm

In 1941 about 140 acres of East Farm II (NW 1/4 of Sec 19) were assigned to the Agronomy

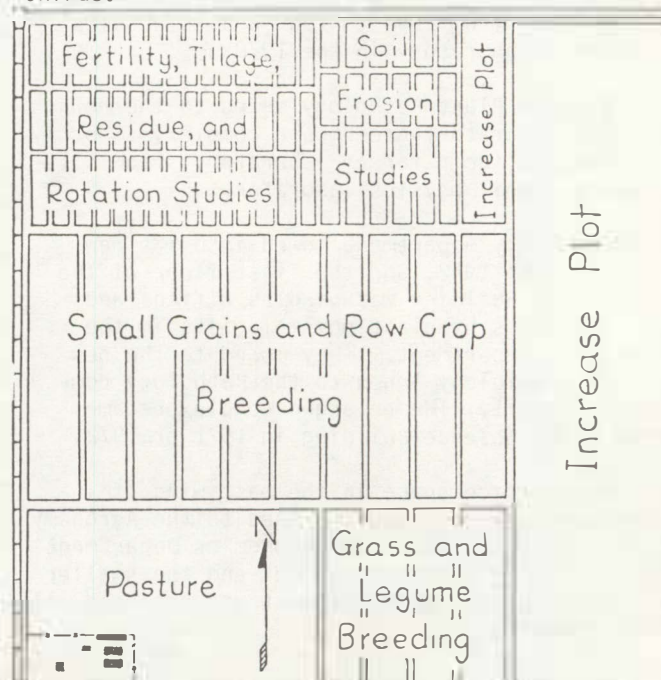
Department. The land was located northeast of the intersection of 11th Street and 22nd Avenue. It had been used as the Horse Farm, home of a dozen or more Percheron mares, for perhaps 20 years.

The buildings on East Farm were retained for use by Farm Services. The house continues (1981) to be the residence for the superintendent of that department. Also, the south 15 acres or so of the pasture were retained by the Farm Services until the late-1950s. It was used as a pasture for milk cows that provided milk for some of the Farm Service employees.



Agronomy Farm in 1955

Though the Agronomy Farm was operated in 1942, the overall plan was designed by W. W. Worzella in 1944. He divided it into rectangular blocks with roadways around each block. A main horseshoe-shaped road was graded and graveled. Each end of the horseshoe served as an entrance along the west side of the farm. The two legs of the horseshoe divided the western half of the farm roughly into thirds.



Agronomy Farm Field Plan in 1955.

The northern third included several crop rotations established by Leo F. Puhr in 1941. It also included several blocks of small grain on which various amounts of crop residue were removed. Edgar Joy, a Soil Conservation Service research scientist, used a wind tunnel on these plots to determine the value of the residue in preventing wind erosion.

The middle third was devoted to a 3-year rotation of row crops, small grain and green manure crops. Row crops included corn and sorghum breeding nurseries and variety performance tests. Small grains included small grain breeding nurseries, performance tests and variety increase fields. At first, sweet-clover was used as a green manure crop, but because of the difficulty in establishing stands, sudangrass was used instead. The southern third of the farm, acquired in the late-1950s, was used primarily for perennial forage crops and barley breeding nurseries.

In 1965 about 25 acres of the farm went to the South Dakota State Highway Department for constructing U. S. Highway 14 Bypass along the north side of the farm and Interstate 29 along the east side. The bypass removed one range of plots from Puhr's soil management experiments and the studies were discontinued. However, the plots devoted to continuous cropping with corn, wheat, oats and rye were adjacent to the main road on the farm. They were continued and, at this writing, have produced 41 crops. The interstate removed another entire range of plots from the east side, but they had not been used for long-term studies.

Also in 1965, L. O. Fine redesigned the plot layout. Gradient terraces were installed on the middle third of the farm and roadways built on the contour. Blocks were no longer rectangular and the north-south roads ran in a northwest-southeast direction.

Other Research Areas at Brookings

An 8-acre plot on the Horticulture Farm, southwest of the Agronomy Farm, was used for weed control research from 1949 to 1963. The east 50 acres of the Olson Eighty, across the road west of the Agronomy Farm, were used for grazing trials from 1951 to 1960. A few years later it became part of the Agronomy Farm. The north half was used for weed control research starting in 1965. The south half was devoted to research with sorghum and soybeans.

About 20 acres of the Larson Farm were assigned to the Agronomy Department for use as a grass breeding nursery in 1965. A similar sized area on the outside of the curve of U.S. Highway 14 Bypass (1 mile east of Agronomy Farm) was designated for the same use.

Agronomy Farm Personnel

Rex Bankert	Foreman	1927-1933
Elmer E. Sanderson	Foreman	1934-1941
Rayburn Butrum*	Foreman	1942-1942
Edmund Stickel	Foreman	1942-1947
Emil Hansen	Assistant	1944-1946
Nels Larsen*	Foreman	1946-1951
Herbert Lund*	Foreman	1/1/1949-
Erwin Whitrock	Field Hand	8/1/48-8/31/77
Arnold Molstad	Assistant	9/1/1951-

*Assistant Foreman for 1 or more years before becoming Foreman.

PLANT PATHOLOGY FARM

In 1955 the west 30 acres of the Olson Eighty were assigned to the Plant Pathology Department for use as a research farm. It was located on the north side of 11th Street about 1/4 mile west of 22nd Avenue. In 1969 the Plant Pathology Farm and Agronomy Farm were merged into the Plant Science Farm. It included all of the Olson Eighty and 124 acres of the Agronomy Farm acquired in 1941 and the late-1950s.

AGRONOMY BUILDINGS

During the 1930s and 1940s, and perhaps earlier years, the Agronomy Department had full use of the "lean to" greenhouse attached to the south end of the Administration Building. The foreman's residence and Agronomy Seedhouse were located west of the Livestock Pavilion, which became the Heritage Museum in 1975.

Reports indicate that the 2-story foreman's residence had been the animal health laboratory and/or as an abattoir. It may have been used for both. The Veterinary Building, shown in the 1891-1892 College Catalog was a square 2-story building at the same location. It may have been the Animal Health Laboratory until the new Veterinary Building was built in 1922. Then it may have then been used as an abattoir until 1927, when the western third of the Livestock Pavilion was added with a meat laboratory in the basement. The house was moved in 1952 from its location west of the Livestock Pavilion to the Agronomy Farm.

A machine shed of frame construction was located on Agronomy West Farm until it was razed in 1952. Lumber from the building was used to build a 2-car garage on the Agronomy Farm for use by the foreman.

The 2-story Seedhouse, which was built in 1904 (K-130), contained a basement, first floor and loft, and it was used for storing research material and as a work area. Later a one-story addition on the east side was used

as a threshing area, machine shed and garage. There was a crude shower room in the basement. During the time that this writer was a student, the Agronomy Farm workers, mostly students, gathered there each evening 6 days a week at 6 p.m. to wash away the grime from a 10-hour day and for the sociability.

The basement was also used for potato storage but few potatoes were raised in the late 1930s or 1940s. A large outside entrance and ramp were constructed at the northwest corner in 1941, making it possible to move machinery into the northern half of the basement for storage.

The building was converted to an animal nutrition laboratory in the early 1950s. The garage was used for conducting digestion trials. The nutrition laboratory was moved to the new Animal Science Building in 1975 and the building was razed in 1977.

An army barracks was secured for the Foundation Seed Stocks Division after the close of World War II. It was east of the Animal Disease Building that was built a few years later in 1949. This laboratory was converted to a gasohol research laboratory during the 1970s.

The barracks housed the seed cleaning equipment and served as a warehouse for cleaned seed that was stored in sacks. One or two round steel grain bins were used to store unprocessed seed.

The 1953 Legislature gave approval to construct the Foundation Seed Stocks Division Building on state owned land. The FSSD borrowed money to pay for it. Since the building was built on state land, it was difficult to use it as collateral. However, banker-philanthropist Herb Clarkson, Sr., of Harding County loaned the FSSD board \$150,000. The building was completed in 1955, and the loan was paid off by 1959 and Governor Hersrud presented the keys to Dr. Fine at a special ceremony (photo page 49). A \$15,000 addition on the east end of the original building was completed in 1965 and used for storing processed seed. A metal seed storage building was completed in 1976 and the machine shed completed in 1980. All buildings were built with funds earned by the FSSD.

The legislature in 1945 appropriated \$100,000 for the new Agronomy Seedhouse. It was completed in January 1947. Most activities were moved to that location, but the old building was used to some extent for several years. In 1947 \$150,000 was appropriated for the Agronomy Headhouse and four greenhouses which were completed in 1949. The Seedhouse and Headhouse each contained modern bathrooms

complete with showers for both men and women. There was also a sleeping room in the northwest corner of the Headhouse. It was thought that students who did greenhouse chores would live in it. Glen Nachtigal, a graduate student, lived in it from 1950 to 1952. James Hay was his roommate for a year. About a decade later, the sleeping room and the men's bathroom were converted to laboratories. The germ plasm storage room in the Seedhouse was enlarged and the herbicide storage room was built in 1977. In 1963, the South Dakota Wheat Commission provided \$9,357.00 for a plant growth chamber. At least some of the money was used in 1964 to build a plastic covered Greenhouse (photo page 33).

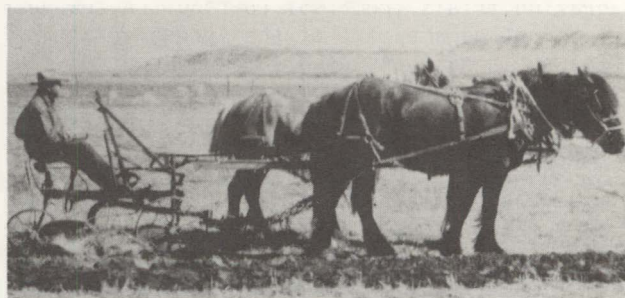
The 1953 legislature appropriated \$275,000 for the Plant Pathology and Botany buildings (JW-64). The Plant Pathology complex, completed in March 1955, included a 40- x 145-foot office-laboratory teaching facility, three 30- x 100-foot greenhouses and a 30- x 125-foot headhouse, all conveniently connected with a glassed-in corridor (Semeniuk). Though the Botany Department did not use the laboratory or offices, it did use one of the greenhouses (photo page 38).

In 1969 the South Dakota Wheat Commission voted to contribute \$100,000 toward the erection of a facility for spring wheat breeding. The 1970 legislature appropriated \$200,000 and the Foundation Seed Stocks Division provided \$40,000 for equipment. Plant Physiology laboratories and two greenhouses were annexed to the Pathology Complex in 1971 (photo page 38). Shortly afterwards, the Pathology and Physiology units were designated as the Plant Science Building.

Two gable-roofed metal machine sheds were erected on the Agronomy Farm in 1952. The open air drying shed was built in the early 1960s--and the electrically heated drying building in 1971 at a cost of \$3,350.

FIELD RESEARCH EQUIPMENT

Prior to 1941 all plot work was done by hand or with horse-drawn machinery. The Agronomy Department owned a team of black Per-



Three horses hitched to sulky plow.

cherons that was stabled in the nearby Horse Barn. Horse-drawn equipment included a sulky (one 16-inch bottom) plow, 7-foot disk, 2-section harrow, 7-foot grain drill, 7-foot grain binder, 2-row corn planter, single-row corn cultivator, single-row potato planter and digger and a hay rack.

Other equipment included a 18- or 20-inch threshing machine that did not have a feeder, band cutters or straw blower; a 2-cylinder Wisconsin stationary engine mounted on skids so it could be moved; a Bollens 2-wheeled garden tractor that was equipped with a cultivator and 3-foot side-mounted mower; several hand-operated V-belt seeders, wheel hoes, long-handled hoes, pitch forks, scythes, hand sickles and corn planters.

The 1/60-acre small grain variety performance and demonstration plots were seeded with the drill and harvested with the binder. Bundles from each plot were placed in two shocks. At threshing time the two shocks from one plot were pitched into the front half of the hay rack and separated by a partition from the two shocks of another plot which were in the back of the rack. At the threshing machine, which was powered by the stationary engine, the twine on each bundle was cut by hand. Then, the bundle was fed into the threshing cylinder by hand. Grain from each plot was collected in separate sacks to be weighed later. From time to time it was necessary to pitch the straw away from the back of the machine.



Preparing to plant head rows.

Plot Work by Hand

Small grain breeding nurseries were planted in smaller plots. Seed of new selections was

planted in head rows 3 to 5 feet long, while seed of later generations was seeded in rod row plots. Prior to planting, the amount of seed needed for each row was packaged in separate envelopes.



Nels Larson threshing plants from head rows. 1948.

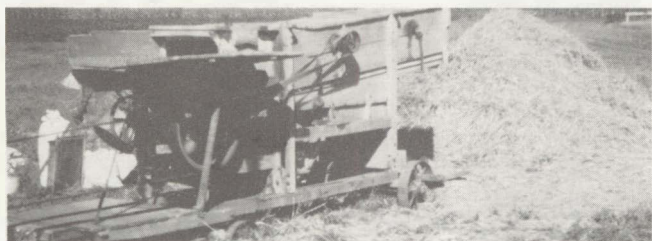
At planting time, the seed was evenly distributed over the length of the belt in a V-belt seeder. As the single-row seeder was pushed, the belt rotated and distributed the seed over the entire length of the row. The seed was fed through a planter shoe, mounted at the front of the seeder, that opened a 1- or 2-inch deep furrow in a previously prepared seedbed and deposited at the bottom of the furrow. Rollers, mounted at the rear of the seeder, covered the seed and firmed the soil over it. By adjusting a partition on the V-belt, the length of row was changed from 5 feet for head rows to 18 feet for rod rows.



Planting with V-belt seeder.

A rod row plot consisted of three 18-foot rows spaced one foot apart. Each row was seeded separately. Plots were cultivated several times with a wheel hoe to control weeds. Shortly before harvest both ends of the plots were trimmed to leave rows one rod long. The grain from the middle row of each 3-row plot was harvested with a short hand

sickle and tied into a bundle. A man straddled the row backwards. As he stooped and backed down the row, he cut the stems and collected them into a bundle. The head of each bundle was inserted into a paper sack to collect any seed that might shatter. The bundles were placed in shocks to dry. When dry, they were threshed in small plot threshers. Nursery threshers, small clipper fanning mills and Emerson Kickers were available for processing seed as early as 1918.



Rod row plot thresher purchased in 1949.

Some large plots of corn were planted with the 2-row planter and cultivated with the single-row cultivator. Other large plots and all small plots were seeded with a hand planter in previously marked rows or hills. A horse-drawn 4-row marker consisted of four 3- to 4-foot 2 x 6's, beveled at one end, spaced 42 inches apart and mounted edgewise on a wooden frame. A tongue and double-tree were attached to the same side of the frame as the beveled end of the 2 x 6's. When drawn through a previously prepared seedbed, it left four 2-inch furrows. When operated in both a lengthwise and a crosswise direction it formed a grid. Hills of corn were planted at the corners of each grid.



Single row corn cultivator.

Hand planters were constructed out of two pieces of 1-inch hard wood that were about 3 feet long and about 4 inches wide at one end and 2 inches wide at the other. Metal tips were attached to the narrow ends and handles on the wide ends. They were hinged together near the narrow end and a spring held the handles apart. The planter was grasped by the handles and the metal tips jabbed into the

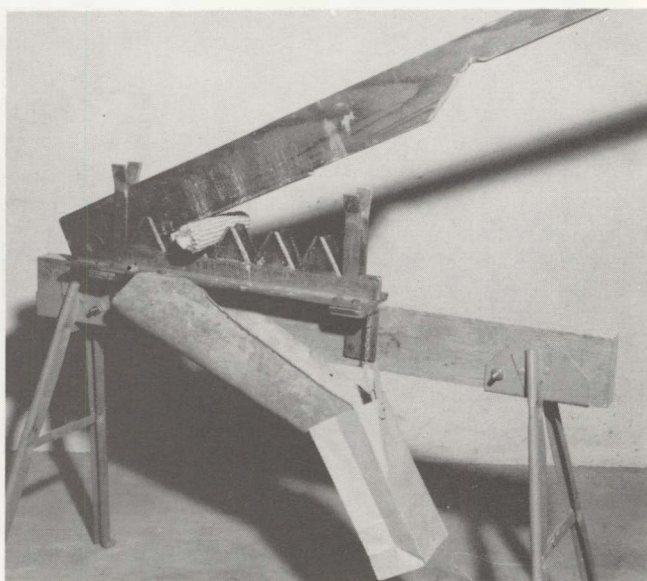
soil to a depth of 2 or 3 inches. Kernels of corn were dropped between the two boards. When the handles were pushed together, the tips opened leaving the kernels in the soil.

All corn plots were harvested by hand. Most pickers used a husking hook. The metal hook was mounted on a leather wrist band that held the hook in the palm of the right hand for right-handed people. A right-handed picker grasped the tip of the ear with his left hand, pulled the hook upwards near the middle of the ear, tearing the husks loose. He then grasped the ear with his right hand and twisted to break it loose from the stalk.

Some pickers used a metal peg strapped to the picking hand so that the tip of the peg was near the end of the thumb. The husk was removed by grasping it near the tip of the ear with the peg and thumb, and ripping it toward the base of the ear.

Two rows of kernels from a representative number of ears were removed with a screw-driver and stored in moisture proof cans as moisture samples. Later, they were run through a Steinlite Moisture Tester to determine moisture content.

This system remained relatively unchanged for 20 years. The hand planters were improved and a cutting apparatus was devised for taking moisture samples. Like a saw horse, 2 x 4's, spaced about 2 1/2 inches apart, were mounted on legs. Each had several mower sickle sections pointing upwards. A third 2 x 4 was mounted between the others with a hinge at one end. When the third 2 x 4 was raised, five



Corn moisture samples.

ears could be laid crosswise on the sickle sections; it was pulled downward to cut a 2- to 2 1/2-inch section out of the ears. The sections fell into a container and were dried in an oven to determine moisture content.

Mechanization

The only self propelled equipment available in 1940 was a 1937 black Ford panel truck owned by the South Dakota Crop Improvement Association for use in its seed certification work. When not being used for that purpose, it was available to the Agronomy Department. This soon changed.

In 1941, a Model B Farmall tractor, with the motor mounted off center; a mounted single-row cultivator; and a one-bottom mounted plow were purchased. Horse-drawn equipment was modified for use with the tractor. The long poles or tongues on the binder and drill were replaced with stub tongues and these implements were used for at least another decade.



Ford tractor and modified horse-drawn binder-1940s.

Also in 1941 or 1942, a 1/2-ton International pickup truck was purchased for use on the Agronomy Farm. It was also used to some extent for transportation to outlying research locations. About the same time, a wagon box was mounted on a 4-wheel rubber tired trailer.

During World War II the Fordson tractor was improved considerably and equipped with the Ferguson 3-point hitch. Numerous Ford-Ferguson implements were developed. Tractor mounted equipment was ideal for plot work. A Ford-Ferguson tractor and a 7-foot tandem disk and 2-bottom plow were acquired in 1946.

Since that time numerous Ford tractors and other mounted equipment have been purchased. The rear-mounted row-crop Ford cultivator was not as easily used as the front-mounted implement on row-crop tractors. The Model B Farmall tractor, cultivator, and plow were traded for a Model C International with 2-row cultivator in 1948. They were still being used in 1980.



Model C Farmall tractor and 2-row cultivator.

John Grafius mounted a V-belt seeder on the Bolens garden tractor and built a divider to deliver seed into four spouts leading to four sets of double disks so that he could plant four rows at a time. Each rod row plot consisted of four 15-foot rows spaced one foot apart. He also built a 4-row cultivator on the tractor that was used for cultivating the plots.

Later he built a 4-row seeder and cultivator on a Model G Allis Chalmers 4-wheel garden tractor. He used a Jari mower to trim plots to a 12-foot length and mounted a hopper on the mower to catch the harvested material from the two-middle rows. It was inserted into a paper bag and tied into a bundle.

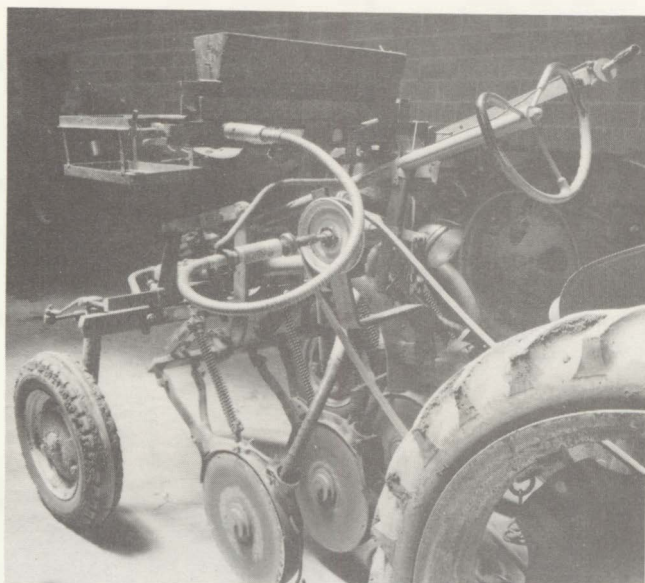


Grafius with 4-row seeder on Bollens tractor-1946.



Jerry Budahl, Eddie Bergerson, Duane Steureman and Wayne Ninneman harvesting rod rows in 1952.

After the Seedhouse was built, bundles were dried in the crop dryer before being threshed. This system was still being used in 1979 except that the belt seeder was replaced by a cylindrical seed divider, and the entire seeder was mounted on a 4-wheel tractor. Both the driver and the man who emptied the previously filled seed packets into the seed divider could ride.



Four-row seeder on Model G Allis Chalmers-1954.

Fertilizer applicators were developed in much the same way. A measured amount of fertilizer was distributed over the length of a belt which deposited the chemical into a divider where it was distributed into several spouts. In some cases a fertilizer applicator and grain seeder were mounted on the same tractor. Several Model G Allis Chalmers tractors were used for seeders, fertilizer applicators and cultivators.

The South Dakota Wheat Commission provided \$3,057 to purchase a commercially built 4-row seeder and \$1,400 in 1970 for a stubble mulch plot seeder. It also provided funds for the Hagie small plot combines purchased to harvest and thresh some plots.



Small grain crew and new plot seeder in 1969.

Sometime before 1950, J. G. Ross and M. W. Adams mounted a V-belt seeder and seed divider on a tandem cultipacker for planting forage legumes and grasses. The divider distributed the seed into six or eight sprouts that deposited the seed on the soil surface between the two rows of packer wheels over a 5-foot swath. They harvested a 3-foot swath with a Jari mower, weighed the material, and saved a small sample which was used to determine moisture content of the forage.



Robert Pylman and new plot harvester in 1974.

During the 1970s corn operations in performance tests were essentially all mechanical from beginning to end: counting the seed into packets, seeding, cultivating, herbicide and insecticide applications at seeding, harvesting with a picker-sheller and electronic moisture determinations.

ANALYSIS OF DATA

During early years all data were processed by hand. It was a tedious process to convert yields per plot into yields per acre, and calculate averages for several plots or several years. Calculators became available during the 1940s making it possible to conduct sta-

tistical analyses of data. This allowed researchers to use replications of smaller plots and actually required less space for any given experiment. Consequently, it was possible to conduct more experiments on the same land area. Even though calculators were improved and could make complicated calculations automatically, data analysis was a time consuming task.

By 1975 the calculations that once were tediously figured on a calculator could be made with the aid of the computer.

Computer programs were secured from other sources and some were developed by departmental personnel. For example, the analysis of variance program secured and revised by D. L. Reeves and J. J. Bonnemann was used by several

projects. The program was periodically updated to include new items and changes to the metric system.

When the Experiment Station first employed a full-time statistician, those working with corn asked him to write a program for analyzing corn yield data. The program he wrote has been upgraded and expanded periodically as the computer facilities expanded.

One improvement in the program was to have the computer make the final printouts of yield tables as presented in the crop performance circulars prepared for publication. This made it possible to analyze data and publish results of crop performance from numerous tests in a matter of weeks from the time the crop was harvested.



Wind tunnel used in the 1940s to measure wind erosion from plots with various amounts of standing stubble and crop residue.



Sugar beet planter used for space planting segregating generations of wheat.

CHAPTER XV OUTLYING RESEARCH STATIONS

For about a decade all agronomic research was done at the main experiment station. However, it soon became evident that crops, cropping systems, and management practices adapted to Brookings were not suitable for use in some other parts of the state. Numerous substations, field stations, development farms and research farms were used for agronomic research through the years.

RESEARCH LOCATIONS IN THE 1920s

Edward W. Hardies was Assistant in Agronomy and Supervisor of Stations from September 1923 to August 1928. Forty years later he wrote a short history about agronomic research. It was forwarded by his brother-in-law C. J. Franzke.

E. W. Hardies

The experimental work was conducted at five stations. The main station was at Brookings where soil investigations assumed a major role. Other experimental stations were located at Highmore, Eureka, Cottonwood and Vivian. An effort was made to have a station in a locality where soil, climatic and environmental conditions were different than from any one of the other stations.

The Highmore Station was one of the first agricultural experiment stations in the Northern Great Plains. Much of the early work was done in cooperation with the USDA. The Highmore Station was noted as the first place in the U.S. where durum wheat, brome grass, yellow-blossomed alfalfa, Siberian pea and Russian olives were proven to be valuable introductions for agriculture.

The city of Eureka was known as the largest wheat shipping center in the world...and the main project at the Eureka station was devoted to testing wheat. Hundreds of varieties were

tested for adaptability, resistance to black stem rust and yielding ability.

The Cottonwood Station was established in an area where grazing and livestock were important. Consequently forage plants were tested there. Species of *Bromus* (brome grass), *Agropyron* (wheatgrass) and *Medicago* (alfalfa) were extensively tested. The area of the station was too small at that time for grazing experiments. As the surrounding prairie was broken, the production of flax and wheat was included in experimental projects.

The climatic conditions at the Vivian Station indicated that sorghum would be a good crop. World War I and the depression that followed resulted in a curtailment of funds. Consequently, the work at Vivian was not expanded.

ALL RESEARCH LOCATIONS

Research locations included the Hunter Farm near Mellette in 1895-1902; substations near Highmore since 1899, Cottonwood since 1909, Eureka in 1908-1971 and Vivian 1913-1942; USDA stations near Newell in 1909-1974, Redfield 1914-1934 and Ardmore; irrigation farms near Huron in 1949-1953, and Redfield since 1949; the Eastern South Dakota Soil and Water Research Farm near Madison since 1960; the Southeast South Dakota Experiment Farm near Beresford and Centerville since 1961; Mobile Research Farms near Watertown since 1956, Menno in 1956-1961, Presho in 1958-1973, Garden City in 1965-1973, Twin Brooks in 1968-1973; and the West River Research and Extension Center at Rapid City since 1974.

Research in several aspects of Agronomy were conducted at these locations. Other research farms had individual projects in weeds, irrigation, clay-pan management or pastures, and are discussed in later chapters.

SUBSTATION ADMINISTRATORS

Clifford C. Willis MSA	Chief of Agronomy	1908-1910
Dr. A. N. Hume	Head of Agronomy	1911-1943
Edward W. Hardies	Supervisor of Stations	1923-1928
Dr. W. W. Worzella	Head of Agronomy	1943-1958
Dr. O. G. Bentley	Director of Exp. Station	1958-1966
Dean D. C. Acker	Director of Exp. Station*	1967-1974
Dr. A. L. Musson	Associate Director	1967-1973
Dr. R. A. Moore	Director of Exp. Station	1973-

Beginning in 1969 administration was transferred to the Plant Science Department for

stations located at Highmore and Eureka, and to the Animal Science Department for Cotton-

wood and Antelope Range.

SUBSTATION STAFF

Numerous members of the Experiment Station staff located at Brookings had charge of the research work at the several substations. Willis took charge of much of the work from 1908 until he resigned in November 1911. Hume then supervised much of the work. Both had assistants, however.

In 1909 an Assistant Agronomist was located at each of the three substations in existence. W. D. Griggs was at Eureka, P. H. Moore at Highmore and Sam Garver at Cottonwood. Manley Champlin had charge of crop experiments from 1912 to about 1921, and E. W. Hardies was Supervisor of substations from 1923 to 1928.

In 1911 J. G. Hutton took charge of all soil investigations. He was succeeded by L. F. Puhr in 1939, L. O. Fine in the late 1940s and early 1950s, B. L. Brage during the 1950s and D. R. Howland in the 1960s.

K. H. W. Klages had charge of cereal breeding and testing from 1928 to 1935 and was followed in succession by S. P. Swenson in 1936-1941, J. E. Grafius in 1942-1953, E. R. Hehn in 1942-1943, V. A. Dirks in 1947-1961 and D. D. Harpstead in 1953-1961.

For 20 years the small grain work was limited primarily to variety performance testing, which was conducted by J. J. Bonnemann after 1961; but D. G. Wells and P. B. Price continued to have winter wheat and barley breeding nurseries at Highmore until the date of this writing.

C. J. Franzke conducted weed control research and corn and sorghum performance tests at the three substations and had corn and sorghum breeding nurseries at Highmore during the 1930s.

Hehn handled the corn performance testing during 1942 and 1943. He was followed by Karl Manke in 1944-1946, D. B. Shank 1947 to 1961 and J. J. Bonnemann since 1961.

HUNTER-SALZER FARM

During 1897 J. H. Shepard, Chemist, and E. C. Chilcott, Agriculturist, stated: "The James River Valley is one of the most fertile tracts of prairie land in the Northwest. Were it not that at intervals dry seasons occur, the belt along the James River would be a veritable Eldorado. The valley is situated in the greatest artesian basin known. Under thousands of square miles lies a sheet of water under pressure that produces huge fountains when pierced by a drill. There is considerable demand for

answers to questions of economics and the possibility of overloading the soils with soluble salts" (Bul 52).

In 1895 the Experiment Station entered into an agreement with the Spink County Land and Irrigation Company, who owned a 700-acre tract of land near Mellette known as the "Hunter Farm", to carry on a series of investigations.

The farm had a complete irrigation plant consisting of a 6-inch artesian well, a 5-acre reservoir and over 5 miles of ditches. The Experiment Station paid the salary of a trained irrigator from California and supervised the work. The John A. Salzer Seed Company furnished seed and the Irrigation Company provided the labor and all needed facilities (Bul 52).

The contract was renewed in 1896. Thirty-eight 1/4-acre plots were sown to various kinds of garden, field and forage crops, mainly in variety and culture testing experiments. In addition the larger portion of 10 acres was divided into temporary plots of varying size and planted to a large number of garden crops. The remaining portion of these 10 acres continued in permanent plots established during the preceding year (Bul 52).

Seeds were obtained from all available sources, from seedsmen, from Experiment Stations and especially from the large seed houses of John A. Salzer Co. of LaCrosse, Wisconsin (Bul 59). For this reason the farm that was called the Hunter Farm in 1895 was renamed Hunter-Salzer Farm in 1896. R. S. Roe was the foreman for a time (Bul 61).

During the first 2 years, 239 plots were planted to over 100 varieties of crops to be harvested for forage. Crops included peas, rape, spurry, vetches, millets, fodder corn, sorghums, sweet corns and sunflowers. In addition, 36 varieties of grasses, alfalfa and clovers were installed in small plots for close comparisons (Bul 59).

In the spring of 1901, the Experiment Station entered into an agreement with the Bureau of Plant Industry, USDA, to cooperate in grain investigations. E. C. Chilcott was in charge of the work and named as collaborator with the USDA. Sylvester Balz was a Special Agent located at Mellette. In the spring of 1903 this work and Balz were transferred to the Highmore Substation (Bul 96).

The 1903 planting included 47 varieties of macaroni (durum) wheat (Bul 84). Some of them may have been planted at Mellette as they had been collected by N. E. Hansen in 1898. No other records pertaining to this research farm were located.

HIGHMORE SUBSTATION

Soon after the appearance of Bul 52 in 1897, announcing the results of cooperative irrigation experiments on the Hunter Farm near Mellette, it became evident that there was an urgent need for experiments with drought-resisting forage plants in the rangeland of the state (Bul 66).

Stockmen urged that Hatch funds be used to establish a substation on the divide between the James and Missouri Rivers, but the U. S. Secretary of Agriculture would not allow such use of these funds (Bul 66).

In 1897 Hon. M. F. Greeley of Gary introduced a bill, drawn by the executive officers of the Experiment Station, in the State Legislature. The bill passed after it had been amended to delete any appropriations. Instead it directed the Board of Regents to set aside a portion of the Hatch funds for that purpose. Again the U. S. Secretary said, "No" (Bul 66).

James Wilson, formerly Director of the Iowa Experiment Station, became U.S. Secretary of Agriculture in 1897. He had a different policy in regard to cooperative work between the USDA and the state experiment stations.

During the winter of 1898-99, E. C. Chilcott, Vice Director of the S. D. Experiment Station, went to Washington, D.C., to examine the possibilities of establishing a range station in South Dakota. He received so much encouragement that Director James H. Shepard submitted a formal proposition. It was favorably received and Thomas A. Williams, who had been at the S.D. Experiment Station from 1891 to 1896, returned to the state to complete the details of the proposed cooperation (Bul 66).

Hon. H. F. Greeley, who had become a member of Board of Regents, and Director Shepard went to Highmore to secure a location.

Hon. Frank Drew, a former legislator, donated the north 117.15 acres of the NW 1/4 of Sec 11, T 112N, R 72W, on the outskirts of Highmore, to the South Dakota Agricultural Experiment Station. The Hyde County Commissioners appropriated sufficient funds to fence the tract and place a suitable building on it (Bul 66).

Williams made a second trip from Washington, D.C., and the final details of the agreement were completed. It was agreed that the Division of Agrostology of the USDA and the South Dakota Agricultural Experiment Station would carry on the work conjointly with both contributing funds and both having access to the results. It was agreed that the work would be limited to the testing of drought-resisting

forage plants and to devising ways and means by which stockmen could obtain winter forage and increase the productivities of the range (Bul 66).

The station was originally called the Cooperative Range Experiment Station. By 1906 it was called Highmore Substation. Dr. Hume referred to it as Highmore Experiment Farm and it was sometimes referred to as the Highmore Substation or Highmore Branch Station. In 1948 it became the Central Substation and in 1972 Central Crops and Soils Research Station.

Highmore Experiment Station 1910 to 1920

Manley Champlin was stationed at Highmore during 1909-1911. In 1912 he transferred to Brookings and took charge of cereal investigations for the Agronomy Department which included the substations. He was a prolific writer. He wrote numerous Experiment Station bulletins and he wrote an article that was published in the *Sioux City Farmers' Tribune*. It was reproduced in Chapter XI of the *History of Hyde County*. The date of the writing is unknown, but the best estimate is 1912-1915.

Manley Champlin

In the central part of South Dakota lies the Ree Valley, a broad expanse of level prairie, hemmed in at the horizon's edge by rounded hills, the moraines left by the glaciers that thousands of years ago brought the soil that made the upper Mississippi Valley the bread basket of the world.

The soil is a rich glacial deposit, varying from 500 to 1,500 feet in depth. The upper soil is a dark loam formed by humus from the decay of the grasses through ages. Its fertility is practically inexhaustible. Under the glacial layer above the ancient shale is a sheet of water fed by drainage waters that constantly filter through the porous glacial drift. This forms a never-failing reservoir to feed the artesian wells of which hundreds have been sunk in late years.

The prairie, in a state of nature, presents a panorama of velvety buffalo-grass that rarely grows above a few inches in height and produces from one-half to one ton of nutritious hay per acre. While this wild hay could not be improved upon and the whole country is thinly settled, the thought often occurred to the far-sighted farmer, "What will we do when the population increases so that the wild hay is not sufficient to supply the demands upon it?"

An experiment station was established at Highmore, the county seat of Hyde County,

situated near the center of the Ree Valley. A piece of land was presented to the state, which was known as the poorest farm in the township. The land was cleared of hard heads, put in a state of cultivation, and a system of selection, variety testing and crop rotation established.

The first object was to develop a drouth-resistant legume. Alfalfas were obtained from Siberia, Turkestan and parts of the United States where conditions of climate were similar. These were planted in testing plots as well as rows which were cultivated for selection. The alfalfa did everything expected of it. The present year it yielded two cuttings of about one ton each per acre and in some years a third cutting has been obtained.

Besides producing about four times as much hay as the wildsod, it improves the ground by adding nitrogen. The value of chopped alfalfa as a feed for cattle is well known, being equal, weight for weight, to bran. The crimson clovers tested, although they can be grown, cannot compare with it for this section.

Three kinds of brome grass were thoroughly tested and carefully improved, with *Bromus intermis*, as usual, winning the laurels. This grass grows to a height of 3 to 5 feet and yields from 1 1/2 to 2 1/2 tons per acre.

Timothies were a success, though in some seasons they failed to catch. Two kinds were grown--a long headed, short-stemmed Russian variety and the common timothy.

The wild western wheatgrass grown under conditions of cultivation proved to be an unfailing yielder. Several other grasses are being tested and grown, but those mentioned seem to be the winners commercially, and the farmer of the future South Dakota with his brome grass and alfalfa can compete well with the eastern farmer and his eastern grasses.

For heavy forage crops, cane, broom corn (proso) millet, foxtail millet and milo maize all proved sure yielders and varieties, especially adapted to the area, have been developed. Seed is being sent out in small quantities and it is hoped that by the time the need is really felt, a sufficient seed stock will be obtainable and the farmer will not be forced to take chances by planting seed not acclimated.

Of all the varieties of maize tried, Minnesota 13 averaged the best. A special strain is being developed for hardness. Also, much is expected of a new variety known as the Brown County Yellow Dent.

Oats yielded from 50 to 70 bushels per

acre, and the quality was all that could be desired, plump, hard grain that over-weighed.

Durum or macaroni wheat yielded an average of 29 bushels per acre and this year will do much better. The Fife and Bluestem varieties have considerable red rust this year and some indications of black rust, but in most varieties this will not be serious enough to greatly reduce the yield. The bread wheats average about 17 bushels per acre.

Barleys, both 2- and 6-rowed, and emmer, commonly known as speltz, have done well for a period of years, yielding ordinarily better than 40 bushels.

The work of the station is educational as well as experimental, being a branch of the State College at Brookings. Many visitors are shown over the place every day, getting object lessons in good farming. Any farmer can obtain yields like those mentioned if he will plant good seed and use similar culture and crop rotation methods. The soil possesses its own fertility and will do its part.

Station Personnel

Resident staff included the Superintendent since 1900 and professional staff for several years.

L. W. Carter		1900-1901
Sylvester Balz	Superintendent	1903-1907
Steve Sussex	Superintendent	1911-1948
Gerald Keehn	Superintendent	1948-1950
Wade Pringle	Superintendent	1950-1964
Frank Holmes	Superintendent	1965-1972
Mike Volik	Foreman	1972-

Botanist DeAlton Saunders laid out the original plots and planted the crops in 1899. He supervised the work done by L. W. Carter in 1900, 1901, and perhaps 1902. Saunders supervised the forage crop work until he left the Agricultural Experiment Station in October 1903.

Sylvester Balz was transferred from the Experiment Farm near Mellette in 1903 when small grain testing was transferred. Saunders was replaced by W. A. Wheeler, who supervised forage crop work for several years (1903-1907) from Brookings. John S. Cole, who was in charge of small grain work at Brookings may have supervised the small grain work at Highmore for a few years prior to 1909.

P. H. Moore was Assistant in Agronomy at Highmore in 1909 and probably lived at the station. Likewise, USDA cooperators or collaborators in charge of cereal investigations lived at the station. They included Manley Champlin in 1909-1911, J. D. Morrison in 1912-1917 and Edgar S. McFadden in 1918-1920.

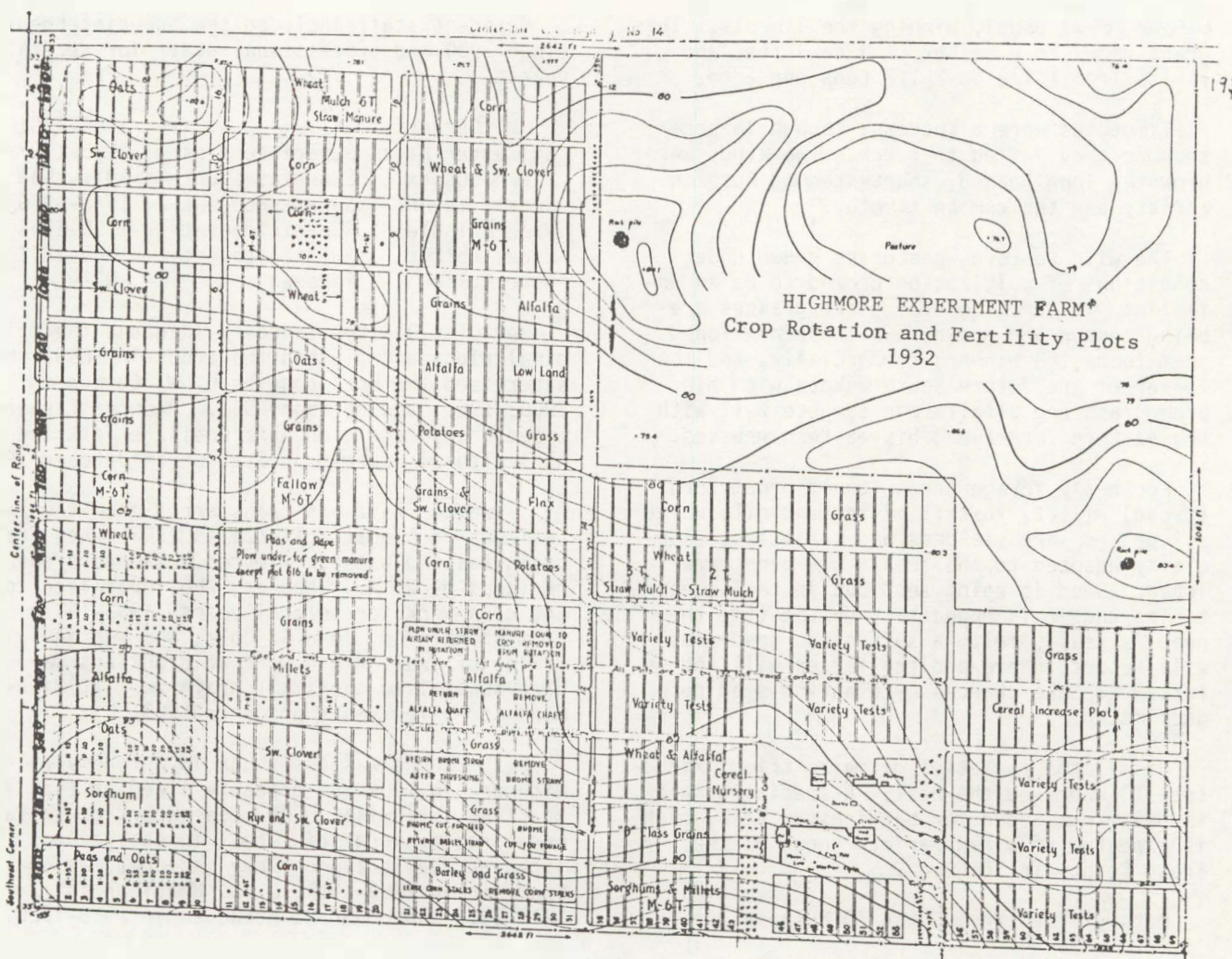
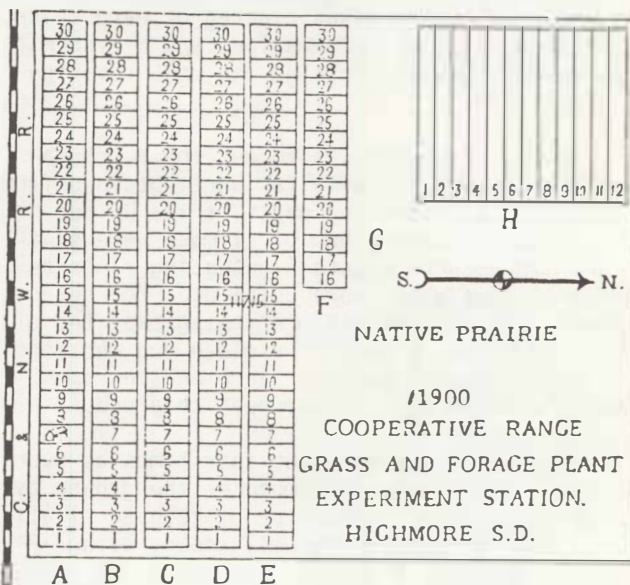
In 1973 Harry A. Geise served as non-resident Superintendent at the same time that he was closing the South Central Mobile Research Farm near Presho. He was transferred to the new Research and Extension Center at Rapid City the next year.

At that time the Northeast Mobile Research Farms near Garden city and Twin Brooks were closed and Quentin S. Kingsley, who had operated those farms, became non-resident Superintendent in 1974. Both Geise and Kingsley had M. S. degrees in Agronomy and planned and conducted some experiments. They also supervised plot work for staff members listed earlier in this chapter and coordinated all activities for the station.

Plot Arrangement

In 1899 Saunders laid out three series (A, B & C) of plots along the south side of the station. They extended the entire length of the farm and were separated from one another by 1-rod driveways. Each series contained 1/4-acre (5x8 rods) plots which were numbered 1 to 30 from east to west. In 1900 series D and E and plots 16 to 30 of series F were added. In

addition, there were 12 long, narrow plots at the northwest corner of the station (Bul 70).

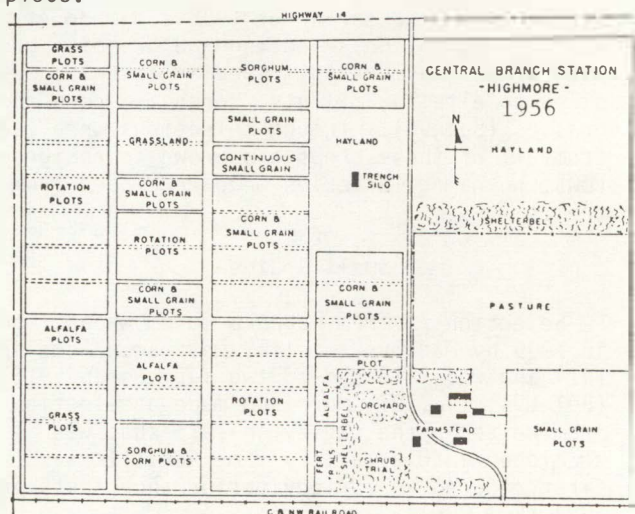


In 1908 Willis modified the plot arrangement. He divided each series into 69 1/10-acre (2x8 rods) plots and numbered them from the west to east. He omitted numbers of plots that had been replaced by the buildings and farm yard. He also added series G to J with 1/10 acre plots numbered 1-33 from west to east (Bul 272).

In 1912 Hume modified the arrangement by adding north-south driveways. In many cases he eliminated every 11th plot making driveways 2 rods wide. With driveways in both directions, each series was divided into 1-acre blocks of 10 plots. Alphabetic designation (A, B etc.) of series was changed to numbers (100, 200 . . . 1,000). In 1913 and 1914, series 1100, 1200 and 1300 were added at the northwest corner of the farm. (Bul 272).

Plot arrangement was modified again. By 1956, four of the five ranges located east of the buildings had been merged into a 5.5-acre block. The fifth range became part of the pasture. Series 1200 and 1300 were lengthened to include three blocks. A gravel driveway was constructed from U.S. Highway 14 to the buildings.

By 1955 the 35-acre pasture in the northeast corner had been reduced to a 20-acre meadow when an east-west tree belt was planted across the south side. A 15-acre pasture south of the trees was created from abandoned plots and the southern part of the original pasture (Cir 272). This grassland and the area planted to an SCS tree demonstration in 1977 were on the Hoven soil and never delineated into research plots.



Buildings and Equipment

The original seed and tool house, built by the Hyde County Commission, was built on Plot A-7 in 1899. Saunders planted Siberian Pea shrubs and Russian Wild Olives on the plot (Bul 66). This plot was located 30 to 35 rods from

the east border of the farm adjacent the south border and served as the entrance.

In the fall of 1901 L. W. Carter wrote, "Arrangements to fence the pasture and build a barn for the team have been made. A sulky cultivator equipped for shallow and deep cultivation and a seed cleaner were bought this fall. A subsoil plow and a 2-horse drill would be valuable additions " (Bul 74).

Prior to 1905 a barn (and perhaps pasture) was put on plots B-6, 7 and 8, which had been seeded to Turkistan alfalfa in 1899 (Bul 96). These plots included an 8- by 15-rod, 3/4-acre area with the southeast corner being about 12 rods from southern border of the farm and 25 rods from eastern edge.

In 1906 Wheeler and Balz wrote, "The work at the station has been seriously handicapped for the past 3 years by inadequate buildings and equipment. The work cannot be enlarged nor improved until new buildings and equipment are secured.

"Thousands of varieties and selections of seeds grown during the past year are stored in a shed where they are likely to be destroyed by pests or lost at any time. The building that is most badly needed is a seedhouse for the storing and handling of plants. It should include a large storage room for small tools and machinery and a sleeping room for the superintendent. A threshing shed, wagon scale, well and additional stable are badly needed in order that the work may progress.

"It is earnestly desired that the next legislature make some provision for new buildings and other equipment needed" (Bul 96).

In 1907 the State Legislature appropriated \$8,000 for buildings and granted a considerable increase in funds for operation and maintenance (Bul 101). It would appear that the house and seedhouse and perhaps a second barn were built in 1907 or 1908. The approximate location of the house was on original plots B-10 and 11, the new seedhouse on B-8 and 9, and the new barn on plot C-10 (Cir 124). In 1917 \$2,000 was appropriated for the operation of substations at Highmore, Cottonwood and Eureka (K-62). The machine shed and poultry house were built prior to 1930 (Bul 272).

The 1 1/2-story house served continuously as the residence of the Station Superintendent. The 1 1/2-story seed house served as a residence for employees from time to time. Sussex lived in it several years after he retired.



Headquarters Central Branch Station in 1956

The barn was used to stable the team used for "horsepower" on the station until about 1950. It also may have been the home of a milk cow and/or a sow and litter kept by the Superintendent for a personal source of milk and meat. The team used in the 1940s was a pair of big dapple grey Percherons. The gelding stood almost 18 hands high and the mare was somewhat smaller as was her colt. Large size was useful when using machinery built for a 3- or 4-horse team, but must have been a handicap when Steve Sussex, who was about 5 feet 5 inches tall, harnessed and unharnessed them.

Early Crop Evaluation

Saunders planted about 50 1/4-acre plots in 1899. One or more species or ecotypes of a dozen grasses, several legumes, several broom corn (proso) millets, several types of corn for fodder and some miscellaneous crops were planted. Much of the seed had been obtained on collecting trips made by T. A. Williams, former Botanist, and N. E. Hansen (Bul 66). In 1900 Saunders, with the assistance of L. W. Carter, planted 40 more species and more plots of some of the same species including alfalfa and smooth brome grass (Bul 70). In 1902 results of the first 3 years were summarized (Bul 75).

1. Nevada bluegrass, feather bunchgrass (green needlegrass) western wheatgrass and smooth brome grass had given promise of being useful for range renewal. No perennial had been found that gave satisfactory hay production.

2. Several annuals had shown themselves to be very drought-resistant and gave satisfactory yield under adverse conditions. Sorghums, corn and millets, in the order named, were recommended for winter feed.

3. Rape, when cultivated, had done well, yielding as much as 14 tons of fodder per acre.

4. Both manuring and pulverizing of native overgrazed prairie had increased the yield of hay per acre.

In 1903 the variety tests, conducted by E. C. Chilcott with the assistance of John S. Cole, were transferred from Mellette to Highmore. HRS and durum wheat, oats, barley and emmer were included in the tests (Bul 84).

Crop Breeding

Most of the crops planted in 1899 and 1900 were very heterogeneous. Research workers began selecting plants that appeared to be most productive and best adapted to the area. John S. Cole and/or Sylvester Balz apparently made some selections of Swedish Select oats during the early 1900s. One of the selections was named Cole.

D. A. Saunders, who was in charge of investigations from 1899 to 1903, left the Experiment Station in October of 1903. W. A. Wheeler, his successor, put more emphasis on the development of improved strains.

In 1904 Wheeler and Balz made plant selections from several types of foxtail millet as the beginning of an effort to develop a better variety. In the spring of 1905 a number of experiments in the selecting and breeding of plants was inaugurated. Special attention was given to alfalfa, millets, sorghums, corn and grasses (Bul 96). Though selections were made from all of these crops and grown in pedigree rows, no named varieties were developed from them.

Small Grains

Selection 7, from Kubanka durum wheat, made in 1909 by Manley Champlin, was named Acme in 1914 and was released to two farmers in 1916 (Bul 194). J. D. Morrison made a selection from White Smyrna barley in 1915 that was developed into a variety name Ace. It was first entered in variety performance tests in 1922 (Bul 256).

In 1918-1920 E. S. McFadden selected the lines from his emmer-wheat cross that he developed into Hope and H-44, the first stem rust resistant varieties of HRS wheat. Hope was released in 1925 from his farm at Webster. He also made several crosses among Lyons, Coast,

Odessa and Club Mariot barley varieties. One of the double crosses became the variety Dryland.

Starting in the 1920s most plant breeding was done at Brookings, but tests conducted at Highmore aided in the selection of lines that were developed into new varieties.

Sorghum

Franzke selected 39-30-S, a variety of forage sorghum low in cyanic acid, at Highmore. In 1936 he used a dairy cow to test for the acid in sorghum plots. This variety and Rancher, selected from it, were the first low prussic acid varieties in the U.S. Drought resistance of sorghum was recognized at Highmore, and Norghum and Reliance grain sorghum varieties were released after extensive testing at Highmore (AES 14).

A selection from Minnesota 13 corn, made at Highmore, was first named Highmore 13 and later named Alta.

Corn

Franzke's corn breeding program began in the 1930s and most nursery work was at Brookings. Highmore was a testing site to select hybrids of the same maturity as at Brookings, but with better adaptation for the lower rainfall areas of the state.

Resulting from this work were such hybrids as SD 204, SD 210, SD 212, SD 220, SD 224 and SD 250, all of which were produced as certified seed and sold to farmers in Central South Dakota for many years.

In addition, 30 newly released inbred lines of corn, selected for stalk rot resistance as indicated by stalk strength, were developed in part by C. M. Nagel from preliminary experiments at Highmore (AES 14).

Forages

During the late 1940s J. G. Ross initiated grass breeding tests at Highmore that contributed to the development and release of Homestead-er smooth brome grass. Strains of intermediate wheatgrass, with high forage yield and large seeds, were recognized at Highmore in 1957 and were used in the development of Oahe intermediate wheatgrass, released in 1962 (AES 14).

In 1916 Garver described the creeping root habit of growth exhibited by the yellow-flowered alfalfa grown at Highmore ever since its importation in 1906 and 1908 by N. E. Hansen. After World War II, M. W. Adams incorporated this characteristic into grazing-type alfalfas. Teton was released in 1958 and Travois in 1963 (AES 14).

Crop and Soil Management

In 1905 W. A. Wheeler and S. Balz established eight 3-year rotations at Highmore on 1/10-acre plots. That fall 16 plots were prepared to test different methods of tillage for the production of corn, wheat, barley and oats (Bul 96).

The series of rotation plots started in 1905 were extended to include 94 1/10-acre plots in 1906. The experiments were conducted in cooperation with the USDA and rotations were planned so that results could be compared with those obtained in North Dakota, Nebraska, Kansas and Texas (Bul 101).

They were modified by C. Willis in 1908. He used thirty-four crop sequences in 3- to 5-year rotations. Some of the crop sequences were (1) wheat-oats-corn, (2) wheat-oats-corn-fallow, (3) oats-barley-corn, (4) corn-wheat-brome-brome-oats and (5) corn-oats green manure crop-wheat (Bul 115).

The number of rotations was increased by using different green manure crops--rye, peas, sweetclover--and by using different methods of seedbed preparation--disking corn stalks and spring and fall plowing (Bul 115).

These rotations were remodified by A.N. Hume during 1912 to include only 10 rotations--(1) corn-wheat-peas-sorghum-oats, (2) corn-small grain, (3) corn-small grain-legumes, (4) corn-rye-sweetclover-millet-small grain-green manure crop of rye or rape, (5) fallow-small grain, (6) corn-oats-wheat, (7) corn-barley-brome-brome-alfalfa, (8) corn-small grain & clover, (9) continuous small grains and (10) corn-wheat-sweetclover.

Each crop occupied a 1-acre block and was handled in several ways by planting more than one small grain or green manure crop, or using different treatments of manure or fertilizer within the block. Two rotations, (11) potatoes-flax-alfalfa and (12) corn-oats-winter wheat were added in 1913 (Bul 272). These experiments were suspended in 1936 due to lack of funds (Bul 325).

With an improved budget for substations in 1942, Leo F. Puhr established new crop rotation experiments at Highmore and Eureka.

The rotations at the Highmore Substation were (1) continuous wheat, (2) corn-wheat, (3) sorghum-wheat, (4) corn-wheat-sweetclover and fallow, (5) sorghum-wheat-sweetclover and fallow and (6) wheat-fallow (Cir 124).

Variety Performance

Since 1903 the Station has served almost continuously as a testing site for small

grains. Over the years these tests helped identify the adapted varieties of spring, winter and durum wheat, oats, barley, winter rye, flax, emmer and millet. The information obtained on yield, other agronomic characteristics and reaction to diseases and insects helped area farmers switch from one variety to a better adapted variety (AES-14).

Richland oats replaced Swedish Select in the Highmore area between 1928 and 1932 because its earliness led to 8% more grain. Mida spring wheat replaced Thatcher because of rust resistance. Pilot replaced Ceres because of stem rust resistance. Lee replaced Mida because of better yields and more rust resistance (AES-14).

Minter winter wheat replaced Turkey in the 1950s because of better yields, straw and hardiness. Twenty years later Scout, Lancer, and Centurk replaced Nebred because of rust resistance and better yields. Hume, Bronze, and Winoka replaced less hardy varieties in some East River acreage. Gent and Sage replaces Scout types because of better leaf rust resistance (AES 14).

Primus II barley replaced Liberty and Plains because of drought resistance (AES-14).

Rates and Dates of Planting Corn

In 1954 Hume initiated a study on dates and rates of planting corn. It was planted in all combinations of 2, 3 and 4 plants per hill on May 1, 20 and 30 using early, mid-season and full-season hybrids. D. B. Shank had charge of the experiment during the 5 years before it was terminated in 1954 (Bul 455).

Forage Evaluation

From 1950 to 1953 L. B. Embry of the Animal Husbandry Department fed early-, medium- and late-cut prairie hay to Hereford steers to determine feed value of the forage harvested at different stages of maturity (Bul 457).

During the mid-1960s Embry compared four supplements to prairie hay for overwintering Hereford steer calves. Twelve calves were fed each of four protein supplements. The supplementary source of protein to a full feed of prairie hay were 6 pounds of alfalfa hay or 2 pounds of a 30% protein supplement as follows: (1) alfalfa hay, (2) 60% soybean meal and 40% ground shelled corn, (3) 48% soybean meal and 52% dehydrated alfalfa meal and (4) 31% soybean meal, 4% urea and 65% ground shelled corn.

Poorest gains were from supplement 1 and best from supplement 2 with intermediary gains from supplements 3 and 4 (Cir 170).

Mulch Tillage

During the early 1960s, F. E. Shubeck conducted experiments to determine (1) if a straw mulch could reduce loss of soil moisture by evaporation and (2) if moisture saved could be exploited by corn to give greater yields (Cir 170).

R. A. Moore grazed several alfalfa varieties with sheep from 1957 to 1962. Teton and Tra-vois, two new pasture-type alfalfas, were compared with hay-type varieties Vernal and Ladak and the yellow-flowered Semipalatinsk for production and persistence under grazing.

Horticultural Crops

Several Russian olives and Siberian peas were planted around the first machine shed in 1899. Sometime before 1930 three or four rows of trees extending from the southern border of the substation northward 10 to 12 rods along the west side of the house were planted (Bul 272). The planting probably included some of N. E. Hansen's newly developed fruits. Many trees died during the drought of the 1930s.

In 1942 another windbreak was planted on the west and north sides of the house. Ten years later windbreaks on the south side of the house and southwest of the house were planted. Trees for a spacing study were planted in 1955 east of the present (1981) drive from the highway to the buildings. These tree plantings demonstrated that a rather wide range of species were adapted to the Highmore area (AES 14).

An orchard, planted in 1942, consisted primarily of apples and plums and stimulated interest in tree fruits in the area. A new orchard was planted in 1975. When limited irrigation became available it served as a good site for evaluating fruit and demonstrating home fruit production in central South Dakota.

In 1965 the Highmore Station was made a part of the regional testing program for woody ornamentals. For several years from 6 to 20 varieties or selections of ornamental trees and shrubs were planted each year.

Three ornamentals which did exceptionally well included Amur chokecherry, Globar caragana and Coronation Triumph potentilla. The Japanese Tree Lilac also performed well until the very dry years of 1974 and 1975. The ornamental plantings at Highmore were a show case of shrubs and trees best adapted for use in landscape plantings in central South Dakota.

In 1977 the Soil Conservation Service planted several species of trees in a demonstration plot on an area of Hoven soil that had never been used for agronomic research.

It was located northwest of the house on the west side of the drive.

NEWELL FIELD STATION

Joseph J. Bonnemann

The Newell Field Station was one of many operated by the USDA during the early part of the 20th century. The station was known by several names during the time it was functional, and served the region well in various capacities and fields of agricultural research.

The Belle Fourche Irrigation Project was one of the earliest programs authorized by the Reclamation Act of 1902. In 1903 survey work on the project was begun, and in 1905 construction was begun on a townsite named for F. H. Newell, then Director and Chief Engineer of the U.S. Reclamation Service.

Orman Dam, was built near Belle Fourche and named for the project engineer. The dam, built with horse-drawn equipment, was the first dam built by the newly formed Bureau of Reclamation to store water for irrigation. Construction began in 1905 and was completed in 1911. It was one of the largest earthen dams of the time.

In the meantime, the Belle Fourche Field Station was established in 1906, primarily to study problems in irrigation (Cir 85). It was located on the northwestern outskirts of Newell on the SE 1/4 of Sec 19, T 9N, R 5E in Butte County near Orman Dam.

However, irrigation water was not available until 1912, and information on dryland farming in the semi-arid portion of the Plains was almost completely lacking. Recommendations on how to grow crops on limited rainfall were based chiefly on experience from the humid area of the Plains or on untested theory. Consequently, the Office of Dryland Agriculture Investigations, Bureau of Plant Industry, USDA, under the direction of E. C. Chilcott, established a Belle Fourche Experiment Farm at Newell in 1907. The Reclamation Service provided \$5,000 for fencing and other construction on the farm (U.S. Tech Bul 454). Chilcott had been Agriculturist and Vice Director of the South Dakota Agricultural Experiment Station for several years.

In 1950 the name was changed to the Newell Irrigation and Dry Land Field Station. Then, in January 1957, the name was shortened to the Newell Field Station. The station ceased to exist as such on June 30, 1974, and in 1979 was being operated by the Black Hills Workshop as a rehabilitation center.

Station Personnel

Since the station was operated by the USDA, the superintendent and most staff members were USDA employees. However, several state employees were located at the station from 1951 to 1969.

C. A. Jensen was the first Superintendent and Agronomist at the station. During his term of 1907-1909, construction was started and preliminary dryland investigations were conducted. Beyer Aune, who had charge of the irrigation-farming investigations and supervised the livestock program, became Superintendent in 1909 and served in that capacity until his death in 1942.

Carl A. Larson served as Superintendent and Soil Scientist in charge of irrigation from 1942 to 1945. Albert Osenburg, who was in charge of dryland research from 1927 until his retirement in 1955, served as Acting Superintendent during the interim of 1945-1946.

Harry E. Weakley, who had been Assistant Agronomist at the North Platte Station, served as Superintendent and Agronomist in charge of irrigation from 1946 through December 1956.

Niel A. Dimick, Agricultural Engineer, transferred to the station in June 1955 to conduct irrigation management research on the Angostura Project and at the station. He served as Acting Superintendent from January 1957 until September 1960.

Jack J. Bond was transferred from Bushland, Texas, to become Superintendent in September 1960. He served in that capacity until 1963 when he resigned to attend graduate school at the University of Nebraska. Carl J. Erickson was appointed Superintendent in late 1963 and continued as Soil Scientist and Superintendent until the station was closed.

The station had many other men on its staff who contributed much to their fields of endeavor. O. R. Mathews, was Agronomist from 1909 to 1926, and retired from the USDA in 1945 as was S. Cecil Salmon from 1908 to 1913 who retired from the USDA in the 1950s. Other early Agronomists included John H. Martin, D. C. Dillman, and Ross D. Davies. They were succeeded by Reinen Bonde, A. D. Ellison, A. Hammerburg, E. M. Johnson, George Ratcliffe and John Wentz. Soil Scientists at the station after 1950 were Bruce L. Baird, James R. Thomas and Harold R. Cosper.

A Watershed Hydrology Unit from the Agriculture Research Service of the USDA was located at the station beginning in 1957. Their studies involved runoff, sedimentation build-up, and various other measurements on paired

watersheds from the rangeland area north and east of Newell to the Cottonwood Field Station and surrounding area. Project leader was A. R. Kuhlmand, Botanist. John Newberger and Clayton Hanson were Engineers. Personnel of the Economics Research Service of USDA, who were at the station for a number of years, included Charles R. Michell during the early 1960s.

State employees, who were part of the station staff and employed by the Agronomy Department, were Joseph J. Bonnemann from 1951 to 1961, and Wilfred E. McMurphy from 1962 to 1964.

Personnel with responsibilities in both Agronomy and Animal Science were James T. Nichols and James R. Johnson, 1964-1969 and 1966-1969, respectively. Joe A. Minyard was an employee of the Animal Science Department from 1961 to 1969. All state employees were transferred to Rapid City on October 1, 1969.

Dryland Rotations

The experimental field was broken out of virgin sod in 1907, and the first crop was grown on uniformly prepared land in 1908. Crops were grown under planned sequences in 1909. Research was directed toward establishing a stable agriculture in the semi-arid and semi-humid lands (Cir 85).

Experiments to determine how crops produced under different methods and moisture conservation were conducted. Crop rotations included winter and spring wheat, oats, barley, corn, sorghum and sweetclover grown in 2-, 3- and 4-year rotations of (1) small grain-corn or fallow, (2) small grain-small grain-row crop or fallow and (3) small grain-row crop-small grain-fallow or green manure crop. Perennial grasses or legumes were included in 5- and 6-year rotations (Cir 85).

Irrigated Rotations

When the Belle Fourche Irrigation District began to furnish water to the station, irrigation-farming investigations were initiated to study the production and utilization of crops adapted to the area. Irrigated rotations, begun in 1912, were terminated in 1950. Farm and shelterbelt studies were carried out under both irrigated and dryland conditions in cooperation with the Forest Service of USDA (Cir 83).

Crop Performance

Experiments to compare crops and varieties of crops were conducted by S. C. Salmon and J. H. Martin from 1909 to 1919. They also compared several rates of seeding small grains and flax at various planting dates. This type

of work was, no doubt, continued by their successors.

Standard Small Grain Variety Trials were conducted annually from 1951 to 1961 when J. J. Bonnemann was located at the station, and continued until 1964 after he took charge of the Performance Testing Program.

Other Research

A selection from Minnesota Amber cane was developed into the variety Dakota Amber by D. C. Dillman and released in 1913 (Bul 174).

Upon termination of the rotation studies, management type of work was begun both on the station and with farmer-cooperators of the Belle Fourche and Angostura Irrigation Projects. In the late 1950s and early 1960s this work was expanded to include range and grassland sites.

Variables under study were many and included: fertility experiments, plant populations studies, water management, soil amendments, grazing intensity, interseeding and pitting of the range, and mountain meadow studies in cooperation with S.D. Game, Fish and Parks to increase browse and many others. Many of the trials resulted from the suggestions of the Advisory Council that was quite active in support of the station.

Livestock research at the station was conducted in cooperation with Bureau of Animal Industry, USDA, from 1912 to 1922. From 1922 until the late 1960s the station worked with the Animal Husbandry Department of SDSC. Much of the early work was with sheep and hogs.

Station Discontinued

The USDA discussed the possibility of closing the station on several occasions (late 1940s, 1959 and 1964) but local opposition prevented its closure. The USDA attempted to give it to the state, but the Agricultural Experiment Station did not have funds or personnel to operate it. State employees were transferred to the newly established West River Research and Extension Center at Rapid City in 1969, and the station finally closed in 1974.

COTTONWOOD SUBSTATION

In 1907 the State Legislature authorized the establishment of an Experiment Farm on the common school endowment or indemnity lands (Sections 16 and 36 in each township) in what was formerly Stanley County, but is now Jackson County. The Board of Regents was authorized to select one section, plow the land and make permanent improvements thereon. "The

said board shall be permitted free use of such lands for such experimental farm purposes so long as the same is so occupied" (Bul 312).

The Cottonwood Experiment Farm consisted of 632 acres in Sec 16, T 1S, R 19E. It was located 2 miles east of the town of Cottonwood. State Highway 14 and the C & NW Railroad ran east and west along the north side of the farm and intersected near the northwest corner of the farm (Bul 312).

The Cottonwood Substation served as a place to introduce varieties and strains of crops from other parts of the world having similar soil and climate. Some introductions became permanent crops in the area. They included sorghums from Africa, sudangrass from Sudan, early small grain varieties (Sixty-day oats and Kubanka durum), Cossack alfalfa and crested wheatgrass from Russia or Siberia (Bul 312).

The station was called the Cottonwood Substation or Cottonwood Experiment Farm or Cottonwood Branch Station. In 1948 the name was changed to Range Field Station and later (probably 1972) to Cottonwood Range and Livestock Field Station.

This writer did not determine when range management studies were initiated. However, by 1954 about 2,000 acres were leased from the Bureau of Land Management for that purpose.

Station Personnel

Dr. N. E. Hansen pioneered the establishment of the Station. Edward Nelson took charge of farm activities even before the buildings were built. Steve W. Sussex was the first foreman after agronomic experiments were installed, but he was transferred to Highmore in 1911.

Samuel Garver was Assistant in Agronomy at Cottonwood in 1909, and USDA collaborator from 1911 to 1914. He may have been located at Cottonwood for 5 or 6 years. Most research was supervised by Experiment Station personnel at Brookings. An incomplete list of Foremen for the station is as follows:

Edward Nelson	1908
Steven W. Sussex	1909-1910
R. K. Turner	
C. H. Wiser	1912-1919
M. B. Hinsvark	
Wesley Feurstenau	1920-1933
Edgar Joy	1933?-1937
Larson	
Eugene Kern	
Frank Whetzel	

Donald Woodford
John Nesvold
Bernard Beer
Joseph Herndin
Lowell Blume

Buildings

The 1909 State Legislature appropriated \$3,000 for buildings at Cottonwood, Eureka and Harding, and \$4,000 was appropriated in 1911 for a house and barn at Cottonwood (K-58). In 1917 \$2,000 was appropriated for operation of the three substations (K-62).

Bulletin 312, printed in 1937, showed a photo of house, barn, seedhouse, machine shed, ice house and pump house. It also showed a small poultry house used by the Superintendent to keep a small flock of chickens for personal use. The buildings were located several rods south from the northwest corner of the northeast quarter.



Headquarters, Cottonwood Substation in 1937.

Plot Arrangement

In 1909 Sussex, under the supervision of Willis, Superintendent of Substations, subdivided about 30 acres into 270 1/10-acre plots. The original series of plots comprised four series. Each of three series contained plots numbered consecutively from 1 to 30 from west to east on North Farm in the northwest corner of northwest quarter. The fourth series contained plots numbered from 51 to 66 on South Farm in the southwest corner of the southwest quarter (Bul 312).

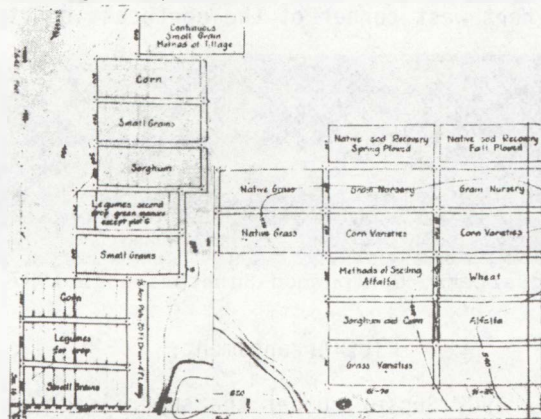
Corn Manure vs. Nops	Corn " " " " " "	Sorghum	Mill Method of Seeding	Oats
Wheat	" " " " " "	Barley	Sudan Method of Seeding	Oats
Legumes (green manure)	" " " " " "	Legumes	Sorghum Method of Seeding	Oats
Alfalfa	Corn Manure vs. Nops	Sudangrass	Barley	Alfalfa Blended Wheatgrass
Peas Manure vs. Nops	Wheat	Barley	Alfalfa	" "
Flax	Oats	Legumes	Alfalfa Blended Grass	" "
Alfalfa Veracruz	Alfalfa Cossack Method of Seeding	Alfalfa Cossack Method of Seeding	Alfalfa	" "
Alfalfa Cossack Method of Seeding	Alfalfa Cossack Method of Seeding	Alfalfa Cossack Method of Seeding	Alfalfa Blended Grass	" "
Rye	Corn " " " " " "	Winter wheat	Sorghum " " " " " "	" "
Rye	Corn " " " " " "	Winter wheat	Sorghum " " " " " "	" "

Field diagram of North Farm at Cottonwood.

On North Farm each series was ten plots (20 rods) wide and was divided into six or eight ranges 8 rods long from north to south. On South Farm the series was laid out in the same manner, with either three or nine ranges (Bul 312).

In 1912 Hume added at least 200 more plots. A fourth series was added to North Farm and two or four ranges were added to all four series making a total of 400 1/10-acre plots. He may have added as many as six ranges to the series on South Farm for a total of 90 plots (Bul 312).

Prior to 1930 six more 1-acre blocks were added to the southeast corner of South Farm. Sometime after 1930, probably in the 1940s, more plots devoted to agronomic research were laid out along the north edge of South Farm, and an experiment on the dates of harvesting native grass plots was on the East Farm.



Field diagram of South Farm at Cottonwood.

Crop and Soil Management

Willis established crop rotation experiments in 1909 which were revised by Hume in 1912. Ten crop rotations installed on the 1-acre blocks included (1) corn-wheat-alfalfa (5-10 yr)-potatoes-flax, (2) corn-wheat-oats, (3) corn-wheat-legume, (4) sorghum-barley-legume, (5) sunflowers-barley-legume, (6) small grain-alfalfa hay-corn-small grain-legume-sorghum, (7) corn-wheat, (8) continuous small grain, (9) rye-corn-winter wheat-sorghum and (10) millet, sudan or amber cane-oats (Bul 312).

Since each acre was divided into 10 plots, many other variables were introduced such as varieties, method of planting, rate of seeding, date of seeding, manure vs. none, method of tillage and depth of tillage (Bul 312). The study was discontinued in 1936 because of a lack of funds (Bul 325).

Crop and Variety Evaluation

Spring and winter wheat, rye, oats, barley, flax, corn, sorghum, sunflowers, potatoes,

millet, sudangrass, alfalfa, sweetclover and several tame and native grasses were evaluated under several production systems in the crop rotations (Bul 312).

Varieties of several crops were compared periodically from 1909 until the mid 1940s. For the next 20 years performance tests for corn and small grain were conducted almost every year. They were discontinued in 1964.

Soil Fertility

A complete soil fertility investigation was conducted on a corn-wheat-legume rotation on North Farm from 1912 to 1936 by J. G. Hutton. The study was terminated for lack of funds (Bul 325).

L. O. Fine initiated new studies on the north part of South Farm around 1950. It was taken over by B. L. Brage in 1958. However, soils on the hill tops and sides were thin, and those in the lower land were salty. It was difficult to obtain information that was of value to a very large area. Consequently, all agronomic work was discontinued in 1964.

Forage Crop Management

In 1942 A. N. Hume initiated a native hay harvesting experiment in which hay was harvested every year, every 2 years or every 3 years to determine the effect on yield and species composition. J. G. Ross continued the experiment in the 1950s after Hume retired. R. A. Moore took over for a few years, but Ross continued the study until 1979.

From 1950 to 1953 L. B. Embry of the Animal Husbandry Department fed early-, medium- and late-cut prairie hay to Hereford steers to determine feed value of the forage harvested at different stages of maturity (Bul 457).

R. A. Moore grazed several alfalfa varieties with sheep from 1957 to 1962. Teton and Travois, two new pasture-type alfalfas, were compared with hay-type varieties Vernal and Ladak and the yellow-flowered Semipalatinsk for production and persistence under grazing.

EUREKA SUBSTATION

In 1907 the State Legislature authorized the establishment of an experiment farm on common school lands (sections 16 and 36 in each township) in McPherson County. The S 1/2 of SW 1/4 and the SE 1/4 of Sec 36, T 127N, R 73W, adjacent to the eastern edge of the town of Eureka, was selected. It included almost 240 acres.

Clifford Willis supervised the establishment of the station in 1908 and 1909 (W-85).

The Station was called the Eureka Experiment Farm, Eureka Substation, North Central Branch Station and finally in 1948, the North Central Substation.

Station Personnel

W. D. Griggs was Assistant in Agronomy at Eureka in 1909, and probably resided on the Station. Most research was supervised by Experiment Station personnel at Brookings.

The names of all superintendents and foremen were not located but the following names and approximate dates of service were found:

William Herman	Foreman	1908-1911
Frank L. Sutherland	Foreman	1912-1919
Walter Schronbrod	Foreman	1930?-1934
Edmund Stickel	Foreman	-9/42
Emanuel Stickel	Acting	1942-1943
Jacob Roth	Foreman	1943-1945
Albert C. Dittman	Supt.	3/46-6/71

Buildings

In 1909 the State Legislature appropriated \$3,000 for buildings at Eureka, Cottonwood and Harding, and \$2,500 was appropriated for buildings at Eureka in 1911 (K-58).

In 1917 \$2,000 was appropriated for operation of the three substations at Highmore, Cottonwood and Eureka (K-62). Circular 103 shows a photo of the buildings as they appeared in 1954. They included a 6-room house, barn, cattle-shed, machine shed, seedhouse, all of frame construction and a poultry house built of rammed earth.



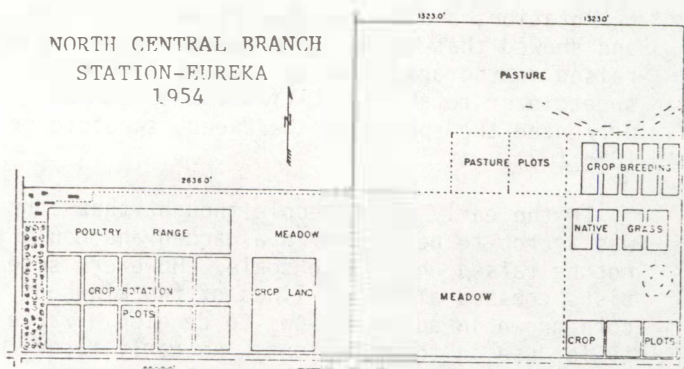
Headquarters of North Central Branch Station-1954

The first buildings were planned by H. C. Solberg, Mechanical Engineer at SDAC. The house, barn and seedhouse were constructed in 1908 and 1909 (Cir 103). The rammed earth poultry house was built by Professor Ralph L. Patty, Agricultural Engineer, in 1940 (Cir 123).

Plot Arrangement

The original plots were delineated by Willis in 1908. They were no doubt modified

by Hume in 1912 and again in subsequent years (Cir 103).



In 1954 about 40 acres of the west "eighty" were subdivided into three ranges. One range was used for a poultry range. The other two were each subdivided into five blocks of about 2 acres (16 x 20 rods) in size and were used for crop rotation experiments. Another 5-acre plot was used for crops. The rest of the 80-acre tract included an orchard along the western edge, buildings at the northwestern corner and about 10 acres of meadow (Cir 103).

The northwest "eighty" included about 8 acres of plots used for crop breeding and a similar acreage for alfalfa grazing trials located along the south side of the tract. The rest was used for pasture (Cir 103).

The southeast "eighty" included almost 70 acres of meadow, three 1-acre blocks for crops, and similar acreage for native grass studies (Cir 103).

Crop Rotations

The crop rotation experiments, initiated in 1908, became the first historical record of the effects of cropping practices on soils in the Northern Great Plains (Cir 102).

At that time the entire surrounding country was planted to wheat. In fact, Eureka was the world's largest shipping point for wheat from 1887 to 1902. There were no crop rotations since the organic matter in the soil was good, fertility was high and there were no weed problems (Cir 103).

Later the Experiment Station was accused of "scattering weeds." Sweetclover was used in a cultivated crops-small grain-legume rotation in an effort to maintain soil fertility and tilth that might be lost by continuous cropping to wheat. In a few years the seed of sweetclover was spread by birds, wind and other modes of dissemination to farms in the countryside, and it grew in the wheat fields. This "plant out of place" was a "weed." Some people felt that Experiment Station Scientists should be fired if they had nothing better to do than scatter

weeds (Cir 103).

Rotations and corn varieties were improved and showed that crops other than wheat could be raised in the area. By using a corn-wheat-sweetclover rotation, cultivation of the corn prevented the spread of the "weed" sweetclover (Cir 103).

In the early years people thought that corn was a crop to be raised in a garden and could not be raised on a large scale. However, scientists crossed alternate lines of two kinds of corn grown in adjacent rows to develop a variety for use in the rotations. An early maturing, good yielding, yellow variety was developed. It was called "Eureka" and enjoyed a great deal of success for many years (Cir 103).

Crop and Soil Management

Clifford Willis established crop rotations at the Eureka Substation in 1908 that were modified by A. N. Hume in 1912 (Cir 103). It is assumed that the rotations were similar to those established at Highmore and Cottonwood.

As at Highmore and Cottonwood, a rotation of corn-wheat-sweetclover was used by J. G. Hutton for 25 years of soil fertility investigations. These studies were suspended in 1936 when funds for substations were curtailed (Bul 325).

When funds for substations again became available in 1942, Leo F. Puhr established a new set of crop and soil management experiments at Highmore and Eureka. The rotations used at Highmore were also established at Eureka, except that continuous wheat and wheat-fallow were omitted, and oats was used instead of wheat (Cir 103).

Forage Evaluation

A. N. Hume started an experiment in 1942. Native hay was harvested annually, biannually and triannually to determine how frequently it should be harvested to get good yields of high quality hay and still leave the grasslands in good condition. J. G. Ross continued the study during the 1950s, and R. A. Moore completed it in 1960.

From 1950 to 1953, L. B. Embry of the Animal Husbandry Department fed early-, medium- and late-cut prairie hay to Hereford steers to determine feed value of the forage harvested at different stages of maturity (Bul 457).

R. A. Moore initiated a study in 1957 in which Teton, Travois, Semipalatinsk, Vernal and Ladak alfalfas were grazed intensively by sheep in order to compare the palatability, quality and persistence of these varieties. When similar experiments were discontinued at

Highmore and Cottonwood in 1962, A. C. Dittman decided to keep it going at Eureka. It was discontinued when the station closed in 1971.

Variety Performance

Varieties of spring wheat, oats and barley were compared for yield, disease resistance and adaptability to North Central South Dakota almost continuously from the opening of the station in 1908 until its closing in 1971.

A half dozen corn varieties were compared from 1912 to 1916. Similar comparisons were made from time to time until 1947 when D. B. Shank took charge of the corn performance testing. After that date, tests were conducted annually at the Eureka Substation by Shank until 1961 and by J. J. Bonnemann until 1971 when the station was closed.

Tree plantings

In the beginning, an attempt was made to establish a plum orchard, but a hail storm damaged the trees so badly that the orchard was abandoned. In 1941 plums, sandcherries, apricots, apples and crab apples, developed by the Horticulture Department, were planted to see if fruit for home use could be grown in the north central area of the state. Other varieties of quality fruit were planted in the 1950s (Cir 103).

Livestock Research

The station was too small to conduct livestock experiments (Hardies). However, in later years there was such a demand for information about livestock and poultry that projects were set up on the establishment of alfalfa in rangeland, on studying the best time to cut prairie hay, and on breeding livestock and poultry (Cir 103).

A flock of registered Hampshire sheep was maintained at the substation in the 1940s. The results indicated possibilities for sheep in the area. However, because of the lack of pasture and farmer interest in research on beef cattle and hog production, the flock was moved after 6 years (Cir 103).

Starting in 1953, a 14- to 18-sow herd was maintained as a breed-line rotation cross in which crossbred gilts produced each season were mated to boars of Hampshire, Duroc Jersey and Yorkshire breeds in their turn in the rotation. The herd was still in existence in 1964 (Cir 170) and may have been maintained until the station closed.

During the 1960s several feeding experiments were conducted by members of the Animal Husbandry Department. For swine, rate of gain

was determined with and without shade and with several rations. Four trials were conducted in which rolled barley fed in several ways and prairie hay were used for finishing beef cattle (Cir 170).

Inbred lines of chickens were compared for egg laying performance and the use of forage for growing turkeys was studied by members of the Poultry Department (Cir 170).

During the 1960s additional land was leased for grazing studies. However, the substation was closed June 30, 1971.

VIVIAN SUBSTATION

In 1911 the State Legislature passed an act that established the Vivian Experimental and Demonstration Farm as a branch of SDSC and the Experiment Station for the purpose of demonstrating the most approved methods of agriculture under Central South Dakota conditions and to do some experimental work (Bul 163).

In 1913 the legislature appropriated \$8,000 for use in fiscal year 1913-1914, and \$3,000 for use in 1914-1915. Funds were for "the construction of suitable and necessary buildings, for the purchase of necessary tools and machinery, farm and dairy animals and equipment, including a silo, seed and necessary expenses, such as help and labor in conducting the demonstration farm at Vivian, Lyman County, South Dakota" (Bul 162).

On April 26, 1913, the Milwaukee Townsite Company deeded 170.69 acres, valued at \$10 per acre, to the state upon condition that the same be used for experimental or demonstration purposes. The farm adjoined the town of Vivian on the north, east and southeast sides of the town (Bul 162). It included parts of the SW 1/4 of Sec 1 T 105N, R 79W and several lots to the west and north of it.

In 1913 a team of horses and some machinery were purchased. Help was hired by the day to put in the crop and fence Northeast Field. The 43.76-acre field of native prairie was "broken" that summer. During the winter of 1913-14, a house and barn were erected (Bul 162).

Expenses for the year 1913-1914 included \$350 for a team of horses, \$6,389.94 for house and barn, \$433.38 for farm implements, \$250 for Superintendent's salary, \$116.70 for seed and supplies, \$44.36 for feed and \$110.84 for travel expenses. One of the mares gave birth to a colt during the year (Bul 162).

When the appropriation for the second year became available, more machinery was purchased, a silo was erected and a good fence was built around the south part of the farm (Bul 162).

The 1915 Legislature appropriated \$1,000 for construction of machine shed and granary (K-62). That year a dairy barn was built. It contained six stalls having metal partitions and two box stalls used for calves and the herd sire (Bul 253).



Headquarters of Vivian Substation during 1920s
1-hog barn, 2 silos, 3-barn, 4-granary, 5-house.

Another special appropriation of \$2,000 was made to the station by the legislature in 1917 (K-62).

Though A. N. Hume and J. G. Hutton were no doubt involved in the planning, Manley Champlin supervised the establishment of the farm.

Station Personnel

E. J. Nelson, the first Foreman, started in 1914. Frank Hussy was superintendent for over 20 years (Cir 123). It was not learned when he started but he held the position in 1930 (Bul 253) and it is believed that he was still there in 1942 when this writer visited the farm during harvest time.

Hutton probably had charge of all the soils investigations performed at Vivian, however, Manley Champlin supervised all agronomic work for several years. E. W. Hardies did likewise from 1924 to 1928. C. J. Franzke may have had charge during the 1930's. E. R. Hehn conducted small grain performance tests in 1942.

Plot Arrangement

Champlin, with the aid of day laborers, laid out the first plots in 1913 in preparation for planting in 1914. Forty-two acres of Northwest Field were divided from north to south into three 14-acre ranges. Two ranges (A & B) were each subdivided east to west into seven 2-acre blocks, but the south range (C) was subdivided into 14 1-acre plots. Beginning in 1920 it was practicable to lay out new plots. The corners were marked with metal and cement stakes (Bul 253).

First Cropping System

The cropping system installed in 1914 included a 3-year rotation of corn or kaoliang, oats and sweetclover. Corn and kaoliang, for silage, were check planted and cross-cultivated (Bul 162).

Field A 21 acres			Field B 21 acres			Field C 21 acres		
A-1 7 acres Brown Flint	A-2 7 acres Vivian 13	A-3 7 acres All Dakota	B-1 7 acres Alfalfa	B-2 7 acres Alfalfa	B-3 7 acres Alfalfa	C-1 7 acres Oats	C-2 7 acres Rye	C-3 7 acres Barley
1 -- CORN			2 -- LEGUME			3 -- SMALL GRAIN		

Three-year rotation at Vivian in 1920s.

Half of the oats was seeded in 6-inch rows and half in three 6-inch row groups, spaced 50 inches apart and cultivated between groups. Oats was raised for grain for the work horses or for hay if it didn't produce grain (Bul 162).

Sweetclover was drilled in rows 3 feet apart shortly after seeding the oats. Sweetclover was to be cultivated in the second year or, in case of failure, to be seeded to oats and peas for hay. Half of the rotation would be cultivated 2 and perhaps all 3 years, but the other half might be cultivated only 1 year. The cultivation would conserve moisture (Bul 162).

Alfalfa was seeded on a 1.76-acre strip along side the other crops. Breaking of the 1-acre plots was done on different dates and at different depths to determine the effect on the crops seeded in different ways (Bul 162).

Pasture Crops

A 20-acre permanent native pasture was maintained on the north edge of the farm next to the main highway. The area immediately west of the pasture was plowed and three north-south strips were seeded to alfalfa and yellow-flowered and white-flowered sweetclovers (Bul 253).

Trees and Shrubs

In 1916 elm, hackberry and cottonwood trees were planted on a small plot north of the buildings. A few green ash and Russian olives were also planted as was a caragana hedge on the north side of the planting. The cottonwoods, which had been planted alternately in the rows with the elm and hackberry, died during the winter of 1923-24. By 1930 only one green ash was alive. However, 40 elms and 40 hackberries, which were spaced 16 feet apart in rows spaced 15 feet apart, were 20 feet high and filled the space left by the cottonwoods. Caragana and currants also did well (Bul 253).

Dairy

In January 1915, Dakota Wayne Cornucopia No. 146074, a Holstein herd sire was purchased.

Two months later two registered Holsteins cows (Aaggie Queen Piebe No. 242582 and Marie Aaggie No. 242576) were purchased from the Grahamholm herd. Soon afterwards enough grade cows were purchased to utilize the six stalls in the dairy barn. The herd consumed grain and roughage produced on the farm, provided a monthly income of about \$60 per month from sale of cream, milk and butter, and furnished a demonstration of a T. B. free herd. The herd was still in existence in 1930 (Bul 253).

Hogs

Prior to 1920 a small herd of Duroc Jersey hogs was established. A 20-acre pasture on rough land cut through by Medicine Creek, seeded to wild grass, alfalfa and sweetclover, was used as a hog pasture and exercise lot. Pathfinder Lady 1st No. 1086380, who placed second in her class at the State Fair, was purchased in September 1921. She farrowed nine pigs each year, 1922 to 1925, and ten in 1926. The herd was used to demonstrate the value of hog cholera vaccine, and some registered animals were sold to nearby hog producers (Bul 253).

Small Grain Performance Tests

Some time in the 1930s, either Klages or Swenson started using Vivian as a site for small grain performance tests. This writer helped E. R. Hehn harvest the plots in 1942.

The substation was closed a year or so later, probably in 1943.

REDFIELD STATION

In 1914 the Redfield Station was established one mile east of Redfield on the north side of U. S. Highway 212 by the USDA. Its purpose was two fold: (1) to introduce and develop more productive and cold resistant varieties of alfalfa for the general area, and (2) to determine methods of planting and management to maintain stands and give higher yields of forage and seed (Bul 383).

Sam Garver, formerly at Cottonwood, took charge of the station. He attended farmer meetings in 1930 and may have been at Redfield until after that date. In 1946 he wrote the Experiment Station bulletin that reported 21 years of research. E. S. McFadden was wheat breeder at the station from 1929 to 1935.

Alfalfa experiments were conducted by USDA personnel from 1914 to 1934, covering a period of 21 crop years. A large percentage of the varieties tested originated in eastern Europe and northern Asia where environmental conditions most closely resembled those of the Northern Great Plains (Bul 383).



Headquarters of Redfield Station in 1930s.

Ladak alfalfa, introduced in 1910 from Leh, British India was first seeded at Redfield. It was planted in rows in 1914. It appeared so promising that in 1916, 1919 and 1921, seed increase blocks were sown. All the Ladak grown in the U. S. was derived from the seed produced at Redfield (Bul 383).

Cossack alfalfa was derived from seed that N. E. Hansen collected from plants growing wild on the dry steppes of Voronezh Province in southern Russia in 1906. A major portion of the developmental work on this variety was done at Redfield (Bul 383).

Turkestan strains of alfalfa, first obtained by N. E. Hansen in 1898, were very hardy and showed the best survival of all varieties tested, but hay production was relatively low (Bul 383).

Many introductions of yellow-flowered alfalfa from western Europe, Russia and Siberia were tested. Growth habit ranged from prostrate to erect, but all proved to be drought- and cold-resistant (Bul 383).

Stand establishment methods and most management practices used in 1979 were similar to those developed at Redfield.

HURON DEVELOPMENT FARM

The Bureau of Reclamation of the U.S. Department of Interior secured the farm on the east bank of the James River 2 or 3 miles south of Huron, South Dakota. The S. D. Agricultural Experiment Station in cooperation with the Agricultural Research Service of USDA conducted the research.

Research began in 1948. Experiments were conducted on non-irrigated and irrigated land to determine the results and benefits under each condition.

The Development Farm was discontinued in 1954 and some of the research is reviewed in Chapter XXIX.

REDFIELD IRRIGATION FARM

A 160-acre farm was leased by the Bureau of Reclamation from Dieters in 1949. The farm, the NW 1/4 of Sec 2, T 116N, R 63W, was located 6 miles east and 1/2 mile north of Redfield in Spink County.

The farm was selected because it was in the area where the Bureau of Reclamation proposed to establish a 200,000-acre irrigation project. Irrigation water could then be obtained from the James River but it was anticipated the water would be provided from the reservoir formed in the Missouri River by the Oahe Dam located north of Pierre.

Initially research was conducted cooperatively by the Experiment Station and USDA, but the latter organization discontinued its efforts in 1959.

The farm was known as the Irrigation Research Substation for several years before being renamed the James Valley Irrigation Research and Extension Center in 1972.

Station Personnel

Most of the research was conducted by staff from Agronomy and Agricultural Engineering Departments, but there was a Superintendent located at the station most of the time.

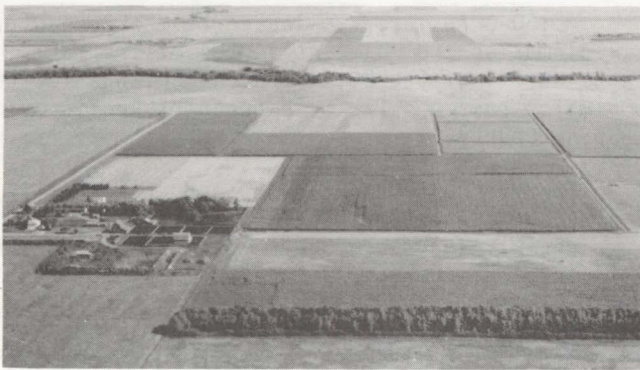
Darold D. Bray	Superintendent	1959-1960
Blume	Superintendent	1960-1961
Lloyd B. Dye	Superintendent	1961-1971
Dr. Raymond A. Ward	Superintendent	1972-1971
Dr. Joseph P. Giles	Superintendent	1972-1979

Lawrence O. Fine had charge of most of soils and water management investigations, and several Agricultural Engineers were involved with water application studies. Small grain and corn performance tests were conducted by Experiment Station personnel listed earlier in this chapter. Weed control research was conducted by W. Eugene Arnold during the 1970s.

After J. P. Giles resigned, Dr. Darrel DeBoer and Albert C. Dittman served as non-resident co-managers during 1979 and 1980.

Plot Arrangement

The farm contained 129.5 acres of tillable irrigated land and 35.3 acres of non-irrigated cropland. Fourteen acres of the irrigated land were an experimental plot area used primarily for agronomic research. The farm was divided into several fields of various sizes. Field 1 contained 12.3 acres, field 2 14.4A; 3, 11.2A; 4, 14A; 5, 17A; 5a, 3A; 5b, 3A; 9, 6A; 10, 6.8A; 11, 19.3A; 12, 4.1A; 13, 6.9A; 14, 12.6A and field 15 contained 31.2 acres. Fields 12 and 15 were non-irrigated land and field 4 was used for agronomic irrigation research (Cir 170).



Buildings and fields at Redfield Irrigation Farm in 1960s.

Buildings and Equipment

The farm, when leased, possessed the normal set of farm buildings--house where the Superintendent lived, barn, granary and several small sheds.

An irrigation pump was installed on the James River about 3/4 mile north of the station and water was piped to Field 1 at the northwest corner of the farm. From that point water was distributed through ditches to the irrigated fields.

During November 1961 four feed lots were built, waterers installed and fence line bunks arranged. Two more lots were built in December. One of these was cross-fenced to make seven usable lots (Cir 170).

During October 1962 a seventh feed lot was constructed. A catch pen, loading chute head gate and working alley were also built (Cir 170).

During September and October of 1963, the feed lot arrangement was completed. It contained eight lots suitable for experimental work--three with access to shelter. One large lot would accommodate 150 calves and provide shelter for about 40. A small lot (hospital), with access to shelter, would hold 15 calves (Cir 170).

In early October 1964 a semi-permanent corn crib with a 3,000-bushel capacity was built (Cir 170).

A house trailer was located directly north of the house. It was used as an office and part-time residence for some summer employees. It was destroyed by fire on May 16, 1978. It was replaced by a similar structure, at the same location, late that fall. The second building was used primarily as an office and a field laboratory.

Research

Since most of the research was conducted under irrigation, it is discussed in Chapter XXIX.

TRAVEL TO SUBSTATIONS

In 1979, on highways that have been straightened and shortened, the highway distances are about 150 miles to Highmore, 225 to Eureka, 250 to Vivian, and almost 300 to Cottonwood. Staff members located at Brookings had to travel long distances by dirt road or railroad to visit these stations. Fortunately an overnight ride by Pullman car on the Chicago and North Western Railroad would take one from Brookings to Highmore or Cottonwood. Probably the best route to Vivian was the C & NW west to Wolsey, a 4- or 5-block trip to the Chicago Milwaukee, St. Paul, and Pacific depot, south to Mitchell, change trains and then proceed west on the same railroad to Vivian.

Eureka was also on a branch of the C M StP & P that connected with the C & NW at Faulkton. Two alternative routes on the C & NW were (1) Brookings to Watertown to Faulkton and (2) Brookings to Huron to Redfield to Faulkton with probable train changes at the towns listed. As time passed, highways and automobiles were improved and the mode of transportation gradually shifted from railroad to the car. Passenger service at Brookings was discontinued around 1960.

Early trips to Highmore were probably made by train or perhaps horse-drawn vehicles. It seems that there would have been few trips with horses because a one-way trip would take 4 to 7 days, depending on whether a buggy or wagon was used and how heavily the wagon was loaded. The Black and Yellow Trail, now U. S. 14, was in existence before 1920 and much of it was gravelled shortly afterwards.

A 6-mile stretch east from Huron was paved in 1928 and 1929, and a similar stretch between Brookings and Volga was paved about the same time. A year or so later, 8 miles of paving was installed west of Huron.

An early photograph of the Highmore Substation, taken before 1910, showed a touring car in the yard. Other early photographs show Dr. Hume's car. Most auto trips prior to the end of World War II were made in privately owned cars. The Experiment Station bought its first vehicle in 1942--a brown Ford sedan.

The Agronomy Department had part-time use of "Black Maria" a 1937 Ford van that the S. D. Crop Improvement Association secured for the Seed Certification Service.

The Agronomy Department purchased an International pickup truck for use on the Agronomy

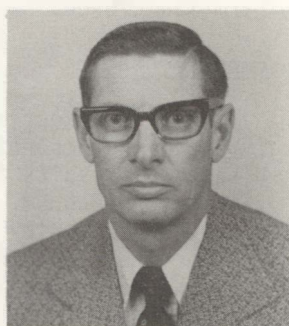
Farm in 1942 that was available for some trips. After World War II, pick-ups, station wagons, and carry-alls were purchased by individual projects, and state-owned vehicles became the common mode of transportation to all out-lying research units.

MOBILE RESEARCH FARMS Q. S. Kingsley and H. A. Geise

During the late 1940s and early 1950s, farmers of the state were asking for more research on crops and soils. They said that research data obtained on the Agronomy Farm at the main Experiment Station and the Highmore, Eureka and Cottonwood substations did not represent the results that might be obtained in their areas.



Q. S. Kingsley



H. A. Geise

Those in northeastern counties were at a high elevation on the Prairie Coteau or the lower elevation of the Whetstone Valley. Farmers in southeastern counties had more rainfall and warmer temperatures than any of the four research locations. Those in south central counties were still concerned about the closing the the Vivian Substation in the 1940s.

Early in the 1950s W. W. Worzella, U. J. Morgaard and E. G. Sandersen conceived of the idea of the mobile research farms. In a discussion with the South Dakota Crop Improvement Board of Directors, it was decided that the SDCIA would ask the Legislature to appropriate money to establish three "Mobile Units"--one each for the southeastern, northeastern and south central areas of the state.

The term "Mobile Unit" was used for two reasons: (1) some of the equipment could be moved from one unit to another to prevent purchasing a full line of machinery for each location and (2) after 5 to 8 years (depending on the nature of the experiment selected) the experimental units would be moved to a new location within the area with an entirely new set of problems such as slope, drainage, fertility and soil type. It was planned that 30 to 50 acres would be leased from farmer cooperators in three separate areas of the state. Crops and soils experiments would be conducted in an attempt to

solve problems pertinent to the areas.

Initially the 1955 State Legislature considered an appropriation for three units. However, conservancy on the part of the Legislature and discretion on the part of the grassroots backing, resulted in the deletion of the south central unit from that bill. It did, however, appropriate funds for northeastern and southeastern farms.

Edward J. Williamson, who had been in the Soil Testing Laboratory for several years, had just returned from a 6-month assignment with a private company in the country of Jordan. He was hired to select the locations and establish the research farms in the two areas.

In each area meetings of interested farmers and county agents were held to set up area committees to assist the Agricultural Experiment Station in selection of the research farms and to plan the experiments. The area committees were composed of the county agents and one farmer from each county in the area.

After looking at several possible locations, a joint committee of farmers and college representatives selected the two locations. For the Northeast Research Farm, a site was selected on the Otto Korth farm in Codington County. It included the northwest 30 acres of the NW 1/4 of NW 1/4 of Sec 7, T 119N, R 52W which was located on the southeast corner of the intersection of Highways U.S. 81 and S.D. 20--13 miles north of the northern edge of Watertown, or 9 miles west of Southshore.

For the Southeast Research Farm, a tract of 20 acres was selected on the Theodore Handel farm, 4 miles east of Menno on U.S. Highway 18 and 1/4 mile north. A lease agreement was signed in which Handel would receive \$15 per acre cash rent and all the crop not needed for research purposes. An additional 3.33 acres were obtained in 1957.

The amount of land devoted to each form of agronomic research, and the specific experiments on fertility and soil management, were determined by the respective area committees.

Each farm or unit represented a particular soil and problem area that was characteristic to that geographical region. The experimental work was performed precisely where the problems occurred. The results of investigations were directly applicable to the regions studied, and it was considerably easier for the people in the areas to observe experiments when they were conducted near their homes.

Plans were made to have annual field days so farmers could observe first hand the results and progress of all experiments in the field.

In addition, it was planned to have a winter meeting in each area to permit the presentation and discussion of results for all people who were interested.

Williamson secured the farm equipment and purchased the buildings needed at each location and laid out the plots for some of the experiments on the Northeast Research Farm. However, in October 1955, he accepted a 2-year assignment in Jordan and resigned. Quentin S. Kingsley, was employed to operate both farms. Fred E. Shubeck, because of his expertise with experimental design and data evaluation was also assigned to work part-time with the farm.

Success in 1955 added incentive for farmer groups to promote the establishment of a research farm in the winter wheat and sorghum growing area. With the promise of much needed tillage research and new winter wheat varieties, the legislature of 1957 passed House Bill 988 which appropriated \$45,000 for the biennium to establish and operate a farm in South Central South Dakota.

Site location was initiated in the spring of 1957 by Dr. W. W. Worzella, Head of the Agronomy Department. Committees were selected as was done for the Northeast and Southeast farms. Originally the site selection committee limited the site location to Lyman, Jones, Gregory, Tripp, Todd and Mellette counties. At later meetings it was decided that the farm should be located in an area west of the Missouri River, south of U.S. Highway 14, east of U.S. Highway 83 and north of U.S. Highway 18. The area was again narrowed to the area west of S.D. Highway 47, south of U.S. Highway 16, east of U.S. Highway 83 and north of the White River on a paved highway.

The final selection, made in 1957, was a 40-acre parcel on the NE 1/4 of Sec 4, T 103N, R 77W. It was on the Glen Hutchison Ranch located 10 1/2 miles south of Presho, S.D. on U.S. Highway 183. A lease agreement was signed for a period of 5 years with the option of extending the lease period and enlarging the area.

After the site was selected in 1957, Kingsley secured the farm equipment and buildings needed for the farm and laid out the plots for winter wheat experiments.

Southeast Research Farm
F. E. Shubeck and Q. S. Kingsley

The farmers and county agent on the Southeast Research Farm Board met at Centerville on July 2, 1955. The board members listed below selected the problems that should be studied. They included experiments involving fertilizer, plant disease control, crop management, soil fertility and variety performance testing.

Officers and members

<u>Officers and members</u>	<u>Address</u>
W. Larson (Chairman)	Beresford
R. Englehorn (Vice Chairman)	Menno
C. Ahrens (Treasurer)	Wagner
H. Boyd (Secretary)	Elk Point
C. Leikvold	Wakonda
A. Gunderson	Lesterville
S. C. Thomas	Springfield
A. Goehring	Delmont
J. Walker	Parker
E. Bowles	Centerville

Herman Wollmann of Menno was hired in 1956, on an 8-month contract, to serve as farm foreman. He was responsible for doing most of the work on the plots and maintaining the equipment. He continued in this position until the farm was closed.

Experimentation

The first experiments were initiated in 1956. High temperatures and drought brought disastrous results for small grain but good yields for sorghum. Variety tests with spring wheat, oats, barley, flax, sorghum, soybeans and corn were conducted. Several varieties of grasses and legumes were planted. Root rot in corn and smut in oats were investigated. Other experiments initiated were types of nitrogen fertilizer for corn, value of legumes in a rotation, comparison of commercial fertilizer to manure and methods of tillage for corn.

The same areas of investigation were carried on in 1957 with additional work on corn and soybean diseases. A comparison of biennial sweetclover, annual sweetclover, red clover and alfalfa for nitrogen fixation and moisture utilization was continued. New experiments included: method of fertilizer application for corn and efficiency of water use by several crops.

New experiments in 1958 involved plant hormones on vegetables and field crops, pre-emergence weed sprays, sorghum planted with a grain drill, soil water evaporation control, insect control and a soybean cyst nematode investigation.

The next year was a year of above average rainfall, but an undesirable distribution caused below average crop yields. Soil moisture under corn that followed several different legumes was measured and variety performance tests of sweetclover and red clover were conducted.

Research Results

A comparison of different types of nitrogen fertilizer for corn production showed that anhydrous ammonia produced the highest yields and

the "organics"--Fertilaid and Super-Gro--did not increase yields.

The value of various legumes in a rotation, for increasing corn yields, depended on rainfall. Highest yields were produced following red clover and lowest following alfalfa for hay. Commercial fertilizer at a ratio of 40-20-0 produced 72 bushels an acre, which was comparable to 78 bushels following red clover.

An annual application of 60-40-0 commercial fertilizer produced higher yields of continuous corn 3 years out of 5 than did 10 tons of manure per acre and more than a treatment consisting of a legume planted between alternate rows with an application of 0-40-0 fertilizer.

Farm Discontinued

In original plans the farm was scheduled to be closed at the end of the 1960 growing season. There was some local opposition to the closing, but it was decided that the research efforts would be transferred to the much larger Southeast South Dakota Experiment Farm located near Centerville and Beresford. The equipment was transferred to the new location the fall of 1960 and the idea of moving the unit every 5 to 8 years was dropped. Research on different soil types and in outlying areas was to be accomplished by satellite actions from a permanent base.

South Central Research Farm
H. A. Geise

Q. S. Kingsley had charge of 1957 activities. He made the farm operational and laid out the plots for winter wheat experiments. The next spring Burton L. Brage, assisted by Harry A. Geise, laid out the remainder of the plots. Geise was hired April 1, 1958, to be superintendent of the farm.

Farm Personnel

Personnel for the station consisted of the superintendent, a part-time foreman on 8-month contract, and usually a high school student during the summer. In addition, some research leaders at SDSC brought their own crews in critical times. The superintendent officed in the Agronomy Department. During the growing season, he was home on weekends, but spent the remainder of the week at the South Central Research Farm and/or the Claypan Research Farm at Plankinton, where he served as plot supervisor for several years.

Those who served as foremen on the South Central Research Farm were Andrew Larvie, Fred Johnson, Jake Boschee, Edgar Nelson, Bart Larson, Dan Clark and Dan Schoenhard.

Farm Facilities

Facilities at the farm consisted of a 32- x 50-foot steel round-roof building erected in 1958 at a cost of \$3,200 and a 24- x 32-foot metal covered pole structure, which was constructed at a cost of \$550 in 1965. The materials for the latter building came as salvage from the former Reed's Ranch which was closed at that date. Another machine shed-office building was constructed at a cost of \$1,100 in 1966.

Equipment for the station was stored in the two buildings. As the station developed the equipment inventory enlarged. All equipment used at the farm were located there--all types of tillage, seeding, harvesting and sample processing equipment. The equipment, vehicles, and supplies were not only utilized at the farm but were used at other nearby sites on experiments conducted by other members of the Agronomy Department.

Research

The first plots were seeded in August 1957 by C. M. Nagel. They were the beginning of a 15-year study of wheat streak mosaic on winter wheat. The experiment was later enlarged to include six dates of seeding at 10-day intervals from mid-August to early-October.

In September the first hard red winter wheat breeding nursery was seeded by V. A. Dirks, wheat breeder at SDSC. The following spring B. L. Brage, and H. A. Geise, established the experiments involving tillage, fertility, crop rotations and variety performance.

Major crop emphasis was placed on winter wheat and grain sorghum. Studies with winter wheat included such variables as methods of fallow, methods of planting, rates and ratios of commercial fertilizer and variety performance tests. The latter included standard varieties from adjacent states as well as experimental lines from their breeding nurseries.

Grain sorghum research included variety trials and management studies involving row spacing, seeding rates, seeding dates, soil fertility, maturity ranges, rotation with spring wheat, weed control and the crossing of breeding lines.

Additional studies were initiated which included variety yield trials of hard red spring wheat, durum wheat, rye, oats, spring barley and winter barley. Forage legume trials were conducted with alfalfa, biennial sweetclover, birdsfoot trefoil and red clover. Perennial grass trials included the wheatgrasses, smooth brome grass, switchgrass and wildrye. The

oilseed crops of sunflowers, mustard, safflower, and crambe were evaluated for their adaptability, and some plant selections were made.

At one point the farm acreage was increased to 45 acres in order to accommodate a rainfall runoff and siltation study. The cover crops were planted, but due to budget freezes, the collection tanks were never installed.

Special short term experiments were conducted which were supported by commercial grants from Northrup-King, American Smelting and Refining and Hershey Chocolate Company. Cooperative experiments were conducted on special problems with other research groups--a wheat rust prediction study with Kansas State University; sunflower adaptation experiments with USDA, Texas A & M and Cargill, Inc. and safflower adaptation tests with Nebraska, Utah, Arizona and California.

Research findings included the winter wheat date of planting study which formulated degrees of control for western wheat streak mosaic based on planting date. Methods of fallowing documented soil-water conservancy. Rates of seeding and row spacing of grain sorghums established production methods for maximum yield under limited rainfall. Performance test data were used for making variety recommendations for several crops. The use of the information increased the income of farmers in the area by millions of dollars.

The possibility of closing the farm was discussed from time to time for several years. Farmers and ranchers in the 9-county area had lost the Vivian Substation several years earlier and wished to keep a research farm in the area, but 1973 was the last crop year.

The Research Farm was closed in 1974. Equipment and personnel were transferred to the West River Agricultural Research and Extension Center in Rapid City. Harry Geise, who was named Assistant Professor of Plant Science, took charge of operations at Rapid City. There was no state-owned land or leased land at Rapid City for doing research work. Geise located and equipped a field headquarters at the town of Box Elder. Research equipment was located there and transported to private farms and ranches where experimentation was conducted.

Northeast Research Farm

Williamson secured the equipment and laid out the plots near Watertown before he left in October 1955. Kingsley then took charge of operations. When it came time to transfer the operation to another location, there was so much local interest that the farm was maintained.

At the same time there was interest in securing such a farm in other areas. In 1965 a satellite farm was established near Garden City. Farmers in the Whetstone Valley still complained that research results did not fit their situation. In 1968 soils work was discontinued at Watertown and a second satellite farm was established near Twin Brooks.

West Prairie Coteau Research Farm

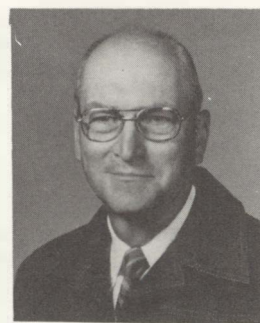
In 1965 the site for a new research farm was located north of Garden City in Clark County. Kingsley had charge of operations. Though some equipment from the Northeast Research Farm could be shuttled back and forth, between the two farms additional equipment was needed. The farm was closed in 1973.

Whetstone Valley Research Farm

In 1968 the site for another new research farm was selected northeast of Twin Brooks in Grant County. Kingsley was in charge of operations and shuttled equipment from the Northeast Research Farm and West Prairie Coteau Research Farm to this farm. The farm was closed in 1973.

SOUTHEAST SOUTH DAKOTA EXPERIMENT FARM F. E. Shubeck and Q. S. Kingsley

During the early 1950s, farmers in southeastern South Dakota were interested in setting up a research farm in that portion of the state. They worked actively with the Directors of the Experiment Station and the Extension Service in discussing the type of projects that could be studied advantageously for this area.



F. E. Shubeck

In 1955 a group of progressive farmers in southeastern South Dakota banded together to form the Southeast South Dakota Experiment Farm Association. Articles of Incorporation were adopted on May 3, 1956.

The bylaws indicate that it was a non-profit corporation formed for the purpose of promoting research in southeastern South Dakota. The organization was authorized to sell \$25 member-

ships in the corporation and certificates of interest for the purpose of raising money to promote the work. Constant, diligent work by the members concluded in 1960 after sufficient funds were raised to purchase the Strubble farm.

The 320-acre farm (W 1/2 of Sec 17, T 95W, R 51W), was in Clay County. The farmstead, on the southwest corner of the farm, was located 6 miles west and 3 miles south of Beresford, S.D. Enough money was raised to pay for the south half of the farm, but a loan was obtained to pay for the north quarter. Experimental

work would be conducted on the south quarter, but the northern portion of the farm was to be used for production for several years to raise the funds to pay off the mortgage.

An appropriation by the 1961 legislature started the wheels rolling at the new Southeast South Dakota Experiment Farm. The farm was available to the Experiment Station beginning March 1, 1961, for experimental work. Work started immediately. Equipment had been moved from the Southeast Research Farm at Menno, land layout, soil sampling and planting of crops followed in proper sequence.

Board of Directors

One or more members (depending on number of memberships in the county) of the Board of Directors was elected for a 3-year term from each participating county. The directors were responsible for the business affairs of the corporation and to assist in accomplishing the purposes set forth in the Articles of Incorporation. A meeting was held each year to allow members to review the activities of the corporation and hear reports on progress of research. The first board was as follows:

<u>Officers</u>	<u>County</u>	<u>Address</u>
Wesley Larsen, President	Union	Beresford
John Walker, Vice President	Turner	Parker
Bernard Uthe, Secretary	Lincoln	Canton
Ercil Bowles, Treasurer	Lincoln	Centerville
Charles Ahrens	Chas. Mix	Wagner
Ervin Clelland	Clay	Vermillion
Carl Wright	Clay	Volin
Leon Jorgenson	Hutchinson	Freeman
Calvin Mettler	Hutchinson	Menno
Eric Thormodsgaard	Lincoln	Hudson
Lawrence Swanson	Lincoln	Canton
Leonard Dailey	Union	Jefferson
William DeJong	Yankton	Volin

The corporation was nonprofit so all funds must be used to advance research or to disseminate results. An annual report summarizing research in progress was prepared each year and sent to every member.

Station Personnel

Quentin S. Kingsley transferred from the Southeast Research Farm in 1961 and Jacob F. Fredrickson was named superintendent. Kingsley officed in Brookings and had charge of agronomic research, while Fredrickson lived in the house obtained with the farm and supervised the livestock experiments.

In October of 1962, Leo F. Puhr passed away and Kingsley was assigned his research duties on the main station near Brookings. Fred E. Shubeck assumed the leadership of the crop and soil experiments initiated by Kingsley and established others. Shubeck officed in Brookings, but spent considerable time on the farm. In 1966, about the time that parts of the north quarter were first used for research plots,

Burton E. Lawrenson was employed as the agronomist. He lived near the farm and served as farm foreman for all plant and soils research.

In 1970 Fredrickson was transferred to the Animal Science Department at SDSU and Richard M. Luther, animal nutritionist at SDSU, moved to the farm to be the superintendent. Four years later he returned to Brookings and Shubeck became the resident superintendent in charge of all research.

Much of the research was planned by project leaders at Brookings. For example, weed control research was conducted by L. C. Warner in 1963-1964, J. Stritzke from 1965 to 1969 and W. E. Arnold beginning in 1970.

Buildings and Equipment

The buildings on the farm included a barn, house, granary, hog barn and some miscellaneous buildings. In 1964 a new swine research building was completed, to study different floor management systems, and the beef feeding facility was built.

The new office building was completed and occupied in October 1971. It contained offices, a laboratory, and meeting rooms. An orchard was planted in 1976 and a solar drying bin was constructed.

A concrete manure holding tank was built east of the swine unit and construction was started on a new cattle feeding unit. Other facilities built on the farm included a drive-on scale, swine finishing barn, steel machine sheds, silos and a hay shed.

Research Planning

In order to keep the research program current and to keep pace with upcoming problems, planning meetings were held at regular intervals with experiment farm directors, county agents, research personnel and other interested people to make known the research needs and to establish priorities.

Agronomy Research

In 1961 Kingsley initiated two experiments. One test involved seven crop rotations ranging from continuous corn to a small grain and legume. Its objective was to determine income from corn, oats, soybeans and sorghum when unfertilized and when using 50 pounds of nitrogen and 20 pounds of phosphorus per acre.

The second experiment involved several fertilizer treatments on corn and oats with residual fertility from each crop being observed the following year.

An experiment initiated in 1962 was a minimum tillage study with corn which involved ten tillage systems and two fertilizer treatments--none and 80-28-0. fertilizer was applied as 60 pounds per acre of 18-46-0 starter fertilizer and 70 pounds of nitrogen in liquid form as a side dressing. The tillage treatments were (1) hard ground listing, (2) listing on fall plowing, (3) listing on fall subsoiling, (4) wheel-track planting, (5) plow-planting (6) conventional planting--plow, disk, harrow and plant--on spring plowing without fertilization (7) conventional planting on spring plowing with fertilization, (8) conventional planting on fall plowing, (9) conventional planting with roto-tilling instead of plowing and (10) conventional planting with stubble mulch instead of plowing.

The hard ground listing plots had no seedbed preparation prior to the listing operation. With the wheel-track planting, corn was planted in the tractor wheel tracks on fresh plowing. For stubble mulch, tillage was done with a wide V blade to keep oats straw and stubble on the surface to see if the organic mulch would be effective in reducing evaporation, conserve water and increase corn yields. Subsoiling was done with a chisel to a depth of about 22 inches to break up compact substrata of these heavier soils. For plow-plant, a one-row planter was bolted on the rear of a mounted plow so that the plowing and planting were done in a single operation. For roto tilling, a roto tiller prepared the seedbed in one operation mixing the stubble through the soil.

Fertilizer application machinery was improved or adapted so that starter fertilizer could be applied for each planting method. Corn yields with minimum tillage methods were excellent in 1962, a very favorable year.

Weed control in corn began to receive attention in 1963 and a forage study was added to the work already in progress.

Row spacing studies with grain sorghum and soybeans began in 1964. Studies involving phosphorus fertilizer requirement and the effect of phosphorus on zinc availability were added.

In 1965 a new corn row spacing and plant population study was started as well as an experiment on the causes and results of corn tillering. In another test corn kernels were planted facing the same direction to see if leaf direction could be controlled to reduce soil moisture loss.

Variety tests of smooth brome grass and intermediate wheatgrass were established.

Starting in 1966 an equal distant corn planting arrangement was compared to 40- and 20-inch row spacing and another new experiment involved tillage and bedding treatments to conserve moisture.

In 1967, a study was performed to measure effect of different soybean row spacings for intercepting radiant energy. In this year, more emphasis was placed on fertilizer placement, methods of application, planting dates and rates of nitrogen for corn. The digestibility of several warm-season grasses grown at the farm were compared using the artificial rumen.

A lime experiment was initiated in 1968. Other new studies tested the effect of weed chemicals plus adjuvant on soybeans and value of soybean blends.

A soil conditioner study with corn and oats was initiated in 1969. Several methods of controlling soil temperatures under corn were explored and the effect on starter fertilizer response was noted.

An experiment with simulated hail damage to soybeans was conducted in 1970. Another investigation concentrated on lowering soil temperatures under alfalfa by use of straw and styrofoam mulches, overhead shade with cheesecloth and an overhead shade of a special plastic that screened out heat waves. Additional work involved herbicide carryover.

New experiments in 1971 included a study of the effect of nitrogen fertilizer on switchgrass and the planting of four varieties of triticale, the new small grain developed by crossing durum wheat with winter rye.

New experiments in 1972 included a chisel plow tillage study and a no-till study with corn and beans. Other investigations involved adjuvants with herbicides for corn and an evaluation of pea beans for the southeast area.

In 1973 new experiments studied herbicide drift, growth regulators for soybeans and the growing of potatoes for the chipping industry. A new animal waste study was begun to determine pollution effects of manure applications, the effect of salt in rations on soil characteristics.

In 1975 a soybean inoculation study began, as did a squash and a pickling cucumber investigation. Other new experiments were studies of seed production of warm-season grasses, fertilization on five spring wheat varieties, high vigor soybeans and an experiment where nitrogen was side-dressed between alternate corn rows rather than between every row.

A severe drought occurred in 1976. About half of the normal rainfall was received. Some studies undertaken included corn or beans after alfalfa in a dry year, continuous soybeans, effect of dicamba on soybeans, foliar fertilization of soybeans and fertilizer and tillage for winter wheat.

A highlight of 1977 was a tour of the farm by a group of Swedish Nationals and the Swedish Ambassador. Some new experiments of the year involved broadcast or drill seeding for oats and iron fertilization of soybeans. Ground truth measurement of solar radiation by Pyranometer was compared for the first time to satellite data for accuracy of crop forecasting.

A severe hail storm occurred July 5, 1978. No soybeans survived. This provided an opportunity to compare late-planted emergency crops

such as millet, buckwheat, sunflowers, milo, forage sorghum, soybeans and early corn for use in this type of a situation.

Exceptional crop yields were obtained in 1979--100-bushel oats, 170-bushel corn and 60-bushel soybeans. Partial summer fallow in some plots after the 1978 hail together with an unusually cold wet spring, caused some of the most severe phosphate deficiency symptoms of corn early in the season that ever occurred on the farm. Phosphorus fertilizer remedied the situation. The solar dryer was filled with corn four times.

Entomology and Pathology Research

An attempt was made in 1965 to find resistance to corn root worm by selection. The next year a new chemical was tested for its ability to control loose smut of barley and narrow row spacings and high plant populations of corn were compared for their influence on the development of certain plant diseases.

Starting in 1967 many insecticides were tested for corn root worm control. The next year a new investigation of insect predators of cereal aphids, was conducted and in 1969 systemic insecticides were compared for the control of greenbugs on sorghum.

Work in 1970 involved studies of the flight activities of an insect predator and southern corn leaf blight. A year later systemic insecticides for first brood corn borer were used.

The use of chemicals to control sunflower moth was studied in 1977.

Animal Science Research

Swine housing and nutrition research began in the spring of 1962. The next year cattle and swine experiments centered around the environment and its relationship to animal nutrition. A farrow to finish swine confinement building was constructed and a S.P.F. herd established.

Cattle feeding trials centered around silage and high moisture ear corn in 1966, while swine research measured effects of floor types (1/2, 1/4 or all slats in each pen)--and of insulated vs. open housing on performance.

The feeding of hormones to swine was investigated in 1968. The next year swine research involved calcium and phosphorus in rations, environmental conditions and protein feed levels. Cattle research centered around ratios of roughage and concentrates and the feeding of an anti-biotic-sulfa drug to calves after weaning and shipping.

With swine, the effect of lysine and methionine supplementation was studied in 1971. Ear corn rations, urea plus sulfur and value of shealters were investigated for cattle. The following year raw and roasted soybeans were tried for swine and different practices for back grounding calves were compared. The value of bloodmeal for finishing pigs was studied in 1975.

During the drought of 1977 the use of drought-stricken silage was evaluated. Two plastic bags of silage filled with an Eberhardt silo press machine were used in the experiment.

During 1978 feedlot performance of exotic crossbred cattle was compared to English breeds. Also the value of implants, and pro-sil treated corn silage was investigated.

A year later cattle feeding experiments evaluated cold flo ammonia added to forage sorghum silage as well as the feeding of cement dust, corn and sunflower silage.

Other Activities

An interesting project, started in 1961, was the conversion of the residential building to electrical heat. Each room was individually metered so the amount of electricity used for each room was recorded. The cost for heating the 6-bedroom house was \$466.34 for the 1961-62 heating season.

The weather station was expanded in 1971 and soil temperatures were relayed to two radio stations. By 1972 automatic instruments measured soil, temperature, air temperature, wind direction and wind velocity.

OTHER RESEARCH FARMS

Several research farms were operated by individual projects and are discussed in later chapters. They include the 2700-acre Pasture Research Center near Norbeck starting in 1963, five Perennial Weed Research Farms located at Scotland, Gary, Brentford, Castlewood and Presho from 1946 to 1966, an irrigation farm located at Lemmon, and the Claypan Management Farm located near Plankinton in the 1950s.



West view of married student housing (buildings of Mid Farm and East Farm in background) from mid-1940s to mid-1960s (Photo in 1949).

CHAPTER XVI CORN

Corn is a native of Central America. It was grown by the American Indians before the 17th century and by the white man in the colony of Virginia in 1608. It was an important crop in Iowa and Illinois before South Dakota became a state (Bul 191).

AGRONOMY PERSONNEL

Early work conducted for the Experiment Station by Luther Foster, the first Superintendent of Agriculture, was to determine if corn could be grown successfully in the Brookings area of the state and, if so, which varieties were best. Also under investigation were the time and rate of planting, and the best methods of cultivation. Varieties were imported and in general were too late. Only the early flints and smallest dents matured. Hickory King, a corn adapted to the southern states was even tried.

During the first 20 years after the Experiment Station was established, all crops were handled by the same personnel--listed at the beginning of Chapter III. They appeared to put more emphasis on small grains and forages, however beginning in 1910 several researchers gave more attention to corn.

Staff Members

W. L. Burlison	1910-1911
Dr. A. N. Hume	1912-1950?
C. J. Franzke	1930--1943
K. L. Manke	1944-1946
Dr. D. B. Shank	1946-1980
G. E. Nachtigal (1/2)	1951-1952
Dr. D. E. Kratochvil (1/2)	1952-1960
Dr. D. W. Beatty (1/2)	1961-1967
Dr. C. M. Nagel	1947-1975

Graduate Students

Glen E. Nachtigal	M.S. **	1952
Stanley D. Jensen	M.S.	1954
Gerhardt W. Erion	M.S. **	1955
Raymond A. Moore	M.S. **	1958
Darrol E. Termunde	M.S.	1958
Paul T. Nordquist	M.S.	1960
Don E. Kratochvil	Ph.D.**	1961
Rodney O. Hexem	Ph.D.	1/9/59-5/30/64
John J. Jenison	M.S.	1976
Michael A. Koopman	M.S.	1977
David W. Peters	M.S.	6/1/77-6/79

** Staff member while in graduate school.

CORN IN SOUTH DAKOTA D. B. Shank

Corn has "grown up" in most of South Dakota along with the Agricultural Experiment Station. At the time the station was organized in 1888 about 630,000 acres of corn were planted, mostly in the southeast corner of the state, with a yield of approximately 16 million bushels.

Corn was planted at Dakota Agricultural College as early as 1888, the first year of the Agricultural Experiment Station. Until the turn of the century most people looked upon corn as a fodder crop in the northern two-thirds of South Dakota.

In 1891 it seemed that there was a distinct line running irregularly across the state, south of which corn was an assured crop. All the dents matured readily, but north of that line only the flints were considered to be reliable. However, researchers believed that it would be an important element in mixed farming (Bul 24). For this reason corn was included in crop rotation experiments initiated at Brookings in 1897 and at the substations at Highmore in 1903, Eureka in 1908, Cottonwood in 1909 and Vivian in 1914.



D. B. Shank cross pollinating corn.

Corn In Early South Dakota
as told by A. N. Hume in about 1950

In 1897 I cultivated all the corn in Spink County. There was then only one field of 40 acres in the county. It was on the farm of Tom Lowry, who lived near Doland.

I came out to South Dakota that summer (1897) from Purdue. When I stopped in Minneapolis to find how to get to Doland, the ticket agent in the Milwaukee station said "You take the Milwaukee to Groton, and from there you catch the Northwestern to Doland." And he slammed the ticket window shut. Those were the days when the railroads did pretty much what they pleased. I changed trains in the middle of the night and recall waking up in the early dawn and looking east over the prairie where grass stood almost shoulder high. It was mostly grass then, tall grass, and a lady on the train who had a small baby remarked to me "It's wonderful to see the prairie again."

Lowry was a former factory worker from Rockport, Illinois, and had never farmed anywhere else. He knew enough about the state, however, to know that the kind of corn grown in Illinois would not do for South Dakota. He grew flint corn at Doland, which he obtained probably from some elevator. He had apparently started the previous year, because I spent the rainy days husking the snapped ears of the previous crop which he had in the bin.

Except for Lowry, no one was growing corn in Spink County at the time. In the early days after the sod was broken, the only crop people thought of was wheat, and everyone wanted to grow wheat from one end of the state to the other. No one thought of rotations or a permanent system of agriculture. At that time (1897), there were less than a million acres of corn, mostly in Southeast South Dakota, and in most of the state there was no balanced farming at all.

To start farmers on a more permanent system of farming we put in corn plots in many places of the state. I planted the first corn in McPherson County which was grown at the Eureka station. It was good corn, and I stopped at the bank there and told the banker that since he was interested in the development of his county he should go out and look at it. He just snorted and said "Kitchen garden. Everyone knows we can't grow corn up here." Yet today (about 1950) there is much corn, even in that county.

One of the reasons for the slow rise of corn in South Dakota in the beginning was the lack of good corn varieties. Each year seed would be brought into the state from Iowa, Indiana

and Illinois. They brought varieties like Reid's Yellow Dent, Leaming and Boone County White, and these varieties did not do very well here. Lowry's flint apparently came from Wisconsin.

Corn For Grain

Minnesota 13, a variety developed at the Minnesota Experiment Station, was planted as early as 1903 at Brookings and in 1904 at Highmore. It consistently produced good yields of grain, and researchers began to think of it as a grain crop for those areas and perhaps for other northern areas (Bul 96).

The use of varieties derived from Minnesota 13 helped enlarge the corn belt significantly and increased production. The 20 million bushels of corn raised in South Dakota during 1915 exceeded the production of any grain crop (Bul 181).

By 1918 varieties had been pretty well tested with the result that Northwestern Dent was recommended for the western and northern areas of the state, Minnesota 13 and Dakota White Dent for the north central area, Fulton Yellow Dent for the south central area, Wimple's Yellow Dent for the southern area, and Reid's Yellow Dent for the Missouri River bottoms east of Vermillion.

By 1923 the use of Alta, Minnesota 13, Fulton Yellow Dent, Silver King (from Wisc 7), Wimple's Yellow Dent and Reid's Yellow Dent (from Illinois), adapted in succession from north to south, had made corn a stable crop. They had contributed millions of bushels of actual cereal, instead of merely fodder. There could be little question but that this silent yet tremendous process had been promoted very substantially by the corn work in the Experiment Station fields (Bul 204).

By 1929 some changes were taking place. One change was in the type of corn that was being favored. Previously, rough starchy ears were favored and thought to excel smooth ears in yielding ability. A. G. Vincent, Letcher, said "Our growers would do well to select only smooth ears. It is a well known fact that smooth corn will mature a little earlier, yield just as much and often more, and is of greater feeding value than rough corn. The East has learned its lesson and everything is in favor of smooth corn. The type of corn grown in the extreme southeastern part of our state is larger than corn grown in other states in competition with us (JW-34).

Acreage increased until 1930 when the greatest amount of land, 5 million acres, was devoted to corn with a yield of 77 million bushels. Then followed a gradual reduction

in acreage which was accompanied by the advent of hybrid corn. For the period 1945 to 1951 an average of 3,921,000 acres produced 102 million bushels of harvested grain annually, and South Dakota ranked among the top ten corn producing states in the United States. Thus corn had changed from a very minor crop to one of the most valuable in the state.

Approximately 4 million acres were planted every year until 1961. Acreage restrictions imposed by the federal Feed Grain Program held the number of planted acres below 3.5 million in most years until restrictions were removed in 1973. Though restrictions were removed from 1973 to 1977, acreage did not increase materially.

The Agronomy and Plant Pathology Departments helped in making corn a leading crop in South Dakota by contributing new varieties and hybrids, and by securing information through research as to the best practices on rates and dates of planting, cultivation methods, fertilization and rotations.

As the number of acres increased, more acres that were not well adapted to corn production were planted to the crop. Nevertheless, average yields increased, especially after hybrids became popular. Ten-year average state yields increased from 24.5 bushels per acre during 1901-1910 to 25.5 in the 1920s, 26.9 in the 1940s, 42.5 in the 1960s and a high of 74 bushels per acre in 1979.

CORN BREEDING

Numerous open-pollinated corn varieties were developed by individual farmers and businessmen during the first third of the twentieth century.

Notes About Early Corn Varieties as told by A. N. Hume to D. B. Shank

Corn got a real boost when South Dakota farmers began breeding corn in this area. Notably among these was A. J. Wimple. Wimple tried to grow corn from the beginning and apparently had something similar to Reid's Yellow Dent. A peddler with a horse-drawn rig came by one year. He had an assortment of corn ears in his wagon which he apparently had collected in his travels and which he was apparently using for feed. Wimple bought the whole lot from the peddler and grew the seeds from each ear in alternate rows and apparently adjacent to his other corn. He followed an ear-to-row method of selection, and from this nursery came Wimple's Yellow Dent. It was widely grown in Southern South Dakota for many years.

Wimple's Yellow Dent had ears that were so rough that they wore out the gloves of the



A. J. Wimple

pickers. According to Henry Preheim, a farmer from Freeman, Wimple introduced corn to Union County, saying that this was the northern and western limit. He brought his corn from the East. His son-in-law, Otto Sundstrom, continued his work after Wimple's death.

Brown County Yellow Dent was originated by Isaac Lincoln, a banker at Aberdeen's Lincoln State Bank. Lincoln was a step-father of Frank McHugh. McHugh lived on the old Lincoln ranch for many years and was active in crop improvement work. Brown County Yellow Dent was noted for its unusually deep kernel.

One of the corns which survived the drought years was Strucka. Strucka, who lived at Reliance, started with Murdock and other yellow varieties. He kept crossing and mixing in Murdock and was able to stay in corn production throughout the 1930s. He baited grasshoppers and selected in the unfavorable years. Strucka corn needed a stiffer stalk and a better shank to keep the ears on.

A. J. Vincent at Letcher was an early grower of corn who promoted Fulton Yellow Dent. He had a reputation for being a real character and was known in his area as "Vonce".

H. E. Dawes made the original selection of Fulton Yellow Dent. He was the banker at Fulton and the actual breeding work was done by Thompson.



H. E. Dawes

A man of whom little is known was William Kemm of Lane, who is reported to have bred corn. Tom Engelbretson of Selby produced a strain of Silver King which was widely grown in Central South Dakota. It

appeared to be later than much of the other

Silver King. Other corn breeders were Carlson of Elk Point and John Rumble of DeSmet and there was a corn man in the Eureka area about 1913 who was demonstrating a corn variety which was earlier than the so called "Eureka Corn", from North Dakota.

Corn had progressed so far in the state by 1906 that an excellent corn show was held at Mitchell. The Corn Growers and Corn Breeders Association was formed at the Corn Palace on September 28, 1906, for the purpose of conducting a corn show and corn school. It also served as a place for corn breeders to display their varieties. A. J. Wimple was at the meeting (JW-2).

Mass Selection

A great deal of stress was placed on the need for selecting good corn for seed. In 1909 people from Iowa were coming to South Dakota for seed. Even though the state could supply seed to others, there was no great supply of fine seed corn (Bul 118).

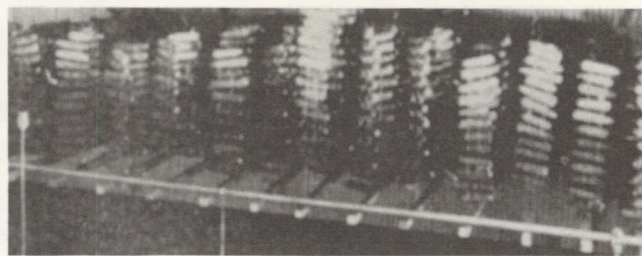
It was suggested that corn growers should be more careful about selecting seed ears and should gather more of them. They should select ears that, when placed under average conditions would produce the greatest amount of good marketable seed corn during the coming season (Bul 118).

The first and best place to make selection was in the field before there was any likelihood of a killing frost. It was suggested that a farmer throw a bag over his shoulder and go into the field looking first for stalks on which ears were borne. If they showed strength, were large and lusty at the base, had good leaves and healthy color, the ears should be examined. Ears should be mature, have medium sized shanks, not be too high from the ground and have good ear characteristics (Bul 118).

The selected ears were hung to dry on specially designed seed corn hangers. The "herring-bone" type hanger consisted of an approximately 1/8-inch rod about 2 feet long with slanting side arms. When each side arm was inserted into the butt end of the cob, the hanger held 2 dozen ears. The hanger was suspended in the granary, barn or even a heated room for rapid drying.

A selection of Minnesota 13 made at Brookings was named SD 86 and later called Brookings 86. Selections from SD 86, made at Highmore, Eureka and Vivian, were called Highmore 13, Eureka 13 and Vivian 13. Highmore 13 was renamed Alta. Eureka 13 was sometimes called Eureka 86 and may have been named Eureka Yellow Dent. However, the latter variety may have been a selection from Northwestern Yellow Dent that produced well

at Eureka, but was very irregular as far as ear shape and color were concerned.



Drying seed corn in the 1920s.

Ear-To-Row Breeding

In 1910 W.L. Burlison started using the "ear-to-row" method of selecting four strains of Minnesota 13. He selected for high and low protein and high and low oil. "Mother ears" were selected. Seed was shelled from each ear and planted in separate rows with seed from each of the four strains being planted in adjoining rows to form blocks or plots of each strain. Ten ears were selected from each row and analyzed for protein and oil content. Seed from ears that possessed the desired qualities was planted in separate rows. The process was repeated annually until 1913. At that time it was concluded that it was possible to develop separate strains of corn, having the same origin, into varieties having high or low protein (Bul 153). SD 86 Low Protein was developed in this experiment.

A. J. Wimple also started to use the ear-to-row method of improving Wimple's Yellow Dent and Wimple's Flint in 1910 (Bul 204).

A. N. Hume conducted two systems of corn breeding by the ear-to-row method at Brookings. In one system, alternate rows were detassled. Silks were fertilized from pollen produced on tasseled rows. Mother ears were selected from the cross-pollinated plants of the detassled rows for the next year's ear-to-row planting. The second system was the same, but none of the plants were detasseled. After 7 years of comparisons it was concluded that the two systems produced corn of equal yielding ability and detasseling was not beneficial (Bul 184).

In 1915 Hume initiated a 3-year experiment with another system of breeding. This system included 96 separate rows in an ear-to-row breeding plot with the total of 96 rows divided into four quarters of 24 rows each. The 24 rows were again divided into two groups of odd and even numbered rows. The even numbered rows were always detasseled and seed was collected from those rows (Bul 186).

Most of the rows were planted from mother ears of Golden Glow developed by the Wisconsin

Experiment Station and grown by Alfred Wenz of Bath. It had gained a reputation for earliness, deep kernels, good quality, and high yield and was adapted to Northern South Dakota. In 1915 one even numbered row in each quarter was planted to each of three other varieties--Fulton Yellow Dent, Minnesota 13, raised at Brookings, and the seed stocks of Leslie McElhaney of Watertown. All were detassled. Four outstanding ears from rows of Fulton Yellow Dent, and two each from Minnesota 13 (SD 86) and McElhaney seed were selected for further propagation. They were planted in even numbered rows and detassled in 1916. Two years later one even numbered row in each quarter was planted to Northwestern Yellow Dent, produced at Eureka, Wimple's Flint and a White Dent (Bul 186).

The variety, All Dakota, was developed from these breeding plots. The breeding began with ears of Golden Glow but ears of Wimple's Yellow Dent, Fulton Yellow Dent, SD 86 Low Protein, McElhaney Yellow, Blackman's Wisconsin 7 (white) and Wimple's Flint were assimilated in the variety (Bul 204).

A 15-acre breeding field was planted on the Percy Ullman farm north of Brookings in 1919 (Bul 186).

Hybridization

In 1930 Hume called attention to the fact that many people engaged in corn breeding were acquainted with the fact that hybrid vigor was brought about by crossing strains of corn that had first been reduced by several generations of selfing or inbreeding. He added that the difficulty in making practical use of hybrid vigor in getting higher yields had been due to the difficulty of outlining a way to utilize it (Bul 245).

Shortly afterwards C. J. Franzke started to self several open-pollinated varieties. In 1936 he explained how hybrid corn was produced. Inbreeding in corn was the process of fertilization when the silks bearing female flowers of a given corn plant were fertilized with pollen from the tassel of the same plant. The genetic factors of the male and female parents came from the same plant and they tended to be alike. To the extent that they were exactly alike the resulting plant was inbred or homozygous. (They were 50% homozygous after the first generation of selfing, 75% after two generations, 87.5% after three, 93.75% after four, 96.875% after five and 98.4475% after six generations of inbreeding). A hybrid resulted from the crossing of two parent plants that were pure-bred or homozygous in respect to characters involved, but were different from one another. A homozygous inbred was a dwarfed plant with shortened internodes that did not

produce much fodder or grain. Not only was its productivity reduced, but its ability to reproduce was also diminished. Some inbred plants did not bear either fertile pollen or ovules (Bul 299).



A. N. Hume, U. J. Norgaard and C. J. Franzke in corn crossing block during 1930s.

Six or seven generations of selfing were necessary to create a relatively homozygous inbred. It was essential that each plant be self pollinated each year. In order to insure self pollination, pollen from the tassel was moved to the silks by hand. Originally the method of transferring pollen consisted of collecting pollen grains in a watch crystal or similar receptacle and then dusting them immediately on the silks of the same plant. Later a large sack was used to cover the entire plant. Pollen dropped to the silks of the same plant, but could not reach other plants.

However, a less laborious technique was devised at Iowa State College. The entire tassel was removed by cutting or pulling it from the plant before it started to shed pollen. The stem of the tassel was put into a 4-ounce bottle of water which was attached to the ear shoot. With this technique a much smaller sack was used to cover only the tassel and ear shoot to insure that only the ripening pollen from that tassel would fall on the silks (Bul 299). Later it was learned that the bottle of water was not needed.

C. J. Franzke selfed Fulton Yellow Dent, Wimple's Yellow Dent, Brookings 86, Alta and Sundstrom 90 to develop seven inbred lines. They were planted in various combinations in isolated crossing blocks to produce single-cross hybrids. For example, two or three rows of SD1 were planted for every row of SD4 in areas free of pollen from other corn fields. The plants of SD1 were detasseled. Since there was no other corn pollen in the area, the silks of SD1, the female parent, were fertilized by pollen from SD4, the male parent.

Seed from the cross-fertilized SD1 was used to produce the single-cross hybrid SD1 x SD4. In a separate isolated area SD2, the female parent, and SD5, the male parent, were handled in the same way. Seed from the cross fertilized SD2 was used to produce the single-cross SD2 x SD5.

In order to produce a double-cross hybrid, the two single crosses were planted at the ratio of three rows of SD1 x SD4 to one of SD2 x SD5. SD1 x SD4, the female parent, was detasseled and cross fertilized with pollen from SD2 x SD5. This produced seed for the double-cross hybrid SD 204.

Franzke developed two other double-cross hybrids (SD 212, SD 224) by using different combinations of the inbreds. SD 212 had the pedigree (SD1 x SD6)x(SD2 x SD5) while SD 224 was (SD1 x SD2)x(SD5 x SD7). SD5 x SD7 was also the male parent for SD 400. It was crossed with a later maturing female parent, WF9 x M14, created from inbred lines developed in Indiana and Moews, Indiana, respectfully, to produce the fourth double-cross hybrid SD 400. All were released between 1941 and 1944.

At that time it was anticipated that members of the South Dakota Crop Improvement Association would plant the inbred lines and produce seed for double-cross production. Farmer growers selected in 1941 and 1942 produced single-cross seed in 1942. Some farmers and several FFA chapters attempted to produce double-cross seed.

However, most growers lacked the facilities and technical information necessary for raising, processing and marketing inbred and single-cross seed. By 1944 a producers cooperative, the Sokota Hybrid Producers of Brookings, South Dakota, was organized, and the company started to produce Certified seed of South Dakota double-cross hybrids. The Foundation Seed Stock Division, established in 1943 at South Dakota State College raised the inbred lines and produced the single-cross seed used by members of Sokota.

Corn breeding was in the hands of Karl Manke during the 1944-1946 growing seasons. He contributed greatly by bringing in inbred lines from other states. He probably made the final evaluations before SD 400 was released. D. B. Shank took charge of the corn breeding program during the fall of 1946. Shank developed 17 more inbreds with SD numbers and 12 more hybrids. C. M. Nagel and John Jenison, plant pathologists, developed 36 inbreds with SD numbers.

Many of the inbreds and single crosses were used by commercial corn seed companies to produce hybrids adapted to South Dakota. During

the early 1960s Shank discontinued the development of South Dakota single- or double-cross hybrids for commercial production. Instead he developed inbreds with specific characteristics that were released to commercial corn seed companies for their use in developing new improved hybrids. Thus many hybrids grown in South Dakota contain germ plasm originating at SDSU.



F. Rosenstalk and D. E. Kratochvil weighing yield samples and taking moisture samples 1954.

Male Sterility

Though producers of double-cross seed could obtain their seed without raising the low producing inbred lines, they still had to detassel the female parent--three-fourths of the corn in a seed field. During the 1950s Shank incorporated the Texas male sterility cytoplasm into several inbreds that were used to produce female parents. The male-sterile female parent of SD 400 was available in 1957. It did not produce pollen and detasseling was not necessary. However, male-sterility was inherited and plants from the seed produced by a male-sterile parent was also male-sterile. Sokota producers planted half their fields to a male-sterile female and half to a male-fertile female; and thereby only half the field had to be detasseled. Special pains were taken to mix the seed from the two-halves of the field at harvest time and again during processing. Though seed sold to commercial corn producers yielded half male-sterile plants, the other half produced enough pollen for the entire field.

Later a male restorer gene was incorporated into lines used as male parents. Though male-sterile seed parents did not produce pollen, their offspring did. Seed producers did not have to detassel any of their fields.

In 1970, however, the southern corn leaf blight fungus attacked much of the cornbelt. All female parents containing Texas male sterility cytoplasm were susceptible to the disease.

Breeders and growers were forced to again use corn containing the normal cytoplasm which meant that it was once again necessary to detassel female parents.

Sources of Inbred Lines D. B. Shank

The productivity of a corn hybrid, as well as its other desirable characteristics, depends on heredity contained in the inbred lines which go into its production. The early inbred lines were, by necessity, developed from open pollinated varieties which were grown in the corn belt prior to the discovery of hybrid corn. With the widespread use of hybrid corn, open pollinated varieties disappeared from farmers' fields. Many of them were collected by corn breeders and held in cold storage for possible use in the development of additional inbreds or as a possible source of suddenly needed traits such as resistance to new diseases. For example, the Agronomy Department stored over 30 such varieties which were collected in the 1940s and 1950s when they were still being grown on farms throughout the state.

By the 1960s corn breeders were having difficulty developing new inbred lines from open-pollinated varieties which gave any better hybrids than those composed of lines bred in the 1940s and 1950s. There was a need to develop germ plasm sources of inbred lines which possessed a higher degree of heredity for desirable traits than open-pollinated varieties that had been used originally. This need resulted in what was called synthetic varieties.

Synthetic varieties have been developed in at least two ways. In either case the germ plasm, either local or introduced, for some desirable trait was used. In one method a complex hybrid was developed from many inbreds.

The second system involved intensive selection for certain characteristics. Residual selfed seed from a predetermined number of the best lines was mechanically mixed and sown on as much as 1/4 or 1/3 of an acre. Sometimes four out of every six rows were detasseled. Silks from these rows were fertilized from pollen produced in the other two rows. Seed was harvested from the detasseled rows which precluded any possibility of self pollination. Generally, the mixture of seed was planted on two or three different dates, making it possible for early maturing selections planted on the last date to pollinate late maturing selections strains seeded earlier and vice versa. Seed from the detasseled rows was planted the next year and individual plants self-pollinated. This was the initiation of cycle two. Seed from any random mated generation could be regarded as a synthetic variety. Seed could be increased for use.

With this technique the more desirable hereditary particles, or genes, from several sources (or selfed selections within one source) were mixed up to form new combinations within the plant cells. The corn breeder could then develop better inbred lines from these new heterozygous (variable) sources which in themselves possessed a greater number of favorable genes than did the original open-pollinated varieties.

Several synthetic varieties were developed in South Dakota. USDA corn breeders at the Northern Grain Insects Laboratory, located at SDSU, mixed seed from 54 sources to develop a synthetic variety that was resistant to corn rootworm. They included seed from lines developed in several states, Mexico and other countries as well as nine SDp inbreds developed by C. M. Nagel for their vigorous roots, disease resistance and strong stalks.

D. B. Shank, J. J. Jenison and D. E. Kratochvil developed a multiple-eared synthetic variety. They self pollinated many two-eared plants selected from open-pollinated varieties. Self-pollinated seed was planted the next year using an ear-to-row method and the plants checked for multiple ears. During the third year, remnant selfed seed from those ears which produced the most desirable multiple-eared plants in the second year was planted in an isolation and allowed to random mate. This was the first cycle of a multiple-eared synthetic. This procedure was repeated for additional cycles as long as variability for the desired trait existed among plants and progress toward the desired objective was being made. New inbred lines were started in the better selfed progenies from each cycle of selection.

Breeding for a Purpose

C. M. Nagel was a pioneer in this field. For over a quarter century he conducted extensive field and greenhouse experiments on the control of the most costly diseases of corn--root and stalk rot, stalk lodging, stalk breakage and ear drop at harvest time. He described his work.

C. M. Nagel

These difficulties were sometimes caused by disease organisms such as fungi (*Fusarium* spp.) or parasitic molds which lived in the soil indefinitely. When seedlings started to develop, these tiny organisms parasitized the roots, spread throughout the susceptible root system and by late season moved up the inside of the stalk and ear shank. During July and August the root system and the inside of the stalk gradually rotted and turned brown; the root system could no longer obtain nutrients from the soil needed to produce high yield.

Although the corn roots and stalks were seriously damaged, symptoms were not obvious until August or early September. As the crop approached maturity, these symptoms became more evident. At the substation near Centerville these diseases caused a reduction in yield of 21.1 bushels per acre. Healthy plants yielded 129.4 bushels and diseased plants only 108.3 bushels per acre.

Research in various states showed how to control many corn diseases, but the control of root and stalk rot diseases proved to be most difficult. The Plant Pathology Department achieved two primary objectives. It devised methods of selecting for disease resistance and stalk strength and developed field equipment to exhume whole mature plants, including root systems. Initially a few hundred plants a day were dug with a spade, but a simple tractor-mounted digger was devised which would exhume 5,000 to 10,000 plants a day without injuring the roots or stalks. Many more plants could be examined, making it possible to make a more accurate evaluation of disease severity. Though some 10,000 plants a day were examined, about 99% of them were seriously diseased and discarded.

A total of 35 inbred lines was developed. The stalk strength was markedly improved, especially with inbred SDp004. In virtually all corn plants whether open-pollinated varieties, hybrids or inbreds, the pith consisted of a soft "cottony" like material that could be pressed between the fingers into a thin layer slightly thicker than a sheet of heavy paper. However, in inbred SDp004 the pith was transformed into a solid woody structure with the density of wood. It split like a piece of wood when a nail was driven into it. The entire stalk, including the rind, pith, joints and ear shank, was markedly improved. These structures were fused together. This inbred, when used in a breeding program, had the potential of improving stalk strength and reducing lodging, stalk breakage and ear drop problems common in inbreds and hybrids across the corn belt.

Many corn inbreds throughout the corn belt developed by other Experiment Stations and used by corn companies to develop hybrids have been compared with these South Dakota inbreds. None have come near to equalling the stalk qualities of SDp004.

CORN VARIETIES, INBREDS AND HYBRIDS

Agronomists developed four varieties, 22 inbred lines, and 16 hybrids, and Plant Pathologists developed 35 inbreds. They helped enlarge the corn belt and increase the overall income of South Dakota farmers.

Open Pollinated Varieties

Brookings 86 (SD 86)--A selection from Minnesota 13 introduced to South Dakota at Brookings in 1903--probably by E. C. Chilcott.

Alta--Selected from SD 86 at Highmore Substation. Selector unknown.

Eureka--Selected from SD 86 at Eureka Substation. Selector unknown.

All Dakota--From pedigreed ears of several varieties. Developed by A. N. Hume.

Inbred Lines

Nine inbred lines were developed that were used only for the production of certified South Dakota hybrids.

<u>Inbred Designation</u>	<u>Parent</u>
SD1	Fulton Yellow Dent
SD2	Wimple's Yellow Dent
SD4	Brookings 86
SD5R	Red kernel mutant in SD5
SD6	Alta
SD7	Sundstrom 90
SD17	(A231 x L317)
SD20	(SD5 x OH56A)
SDpl	Fulton Yellow Dent (Formerly called P 236)

Another 15 inbred lines were developed that were released to commercial corn breeders. Many of them have been used in numerous hybrids that corn companies sell to South Dakota farmers.

<u>Inbred Designation</u>	<u>Source</u>	<u>Year Released</u>
SD5	(1210 x B107)	1950
SD26	Minnesota 13	1959
SD48	Fulton Yellow Dent x (1210 Brookings 86)	1958
SD10	(B8 x OH56A)	1965
SD15	(OH56A x Silver King) x OH56A	1964
SD23	OH43 x Ellis Yellow Dent	1971
SD9	Yellow inbred from single red O.P. ear	1975
SD18	A1883 (SD26)	1975
SD22	(W22 x Falconer)	1976
SD24	[(B14 x Gaspe) x 1] x B14	1975
SD25	(SD5 x OH56A) x SD5	1976

SD28	B8 ₂ (unknown inbred)	1975
SD29	(B8 ₂ ND230 x SC213) x SD28	1976
SD30	Pioneer Hybrid 3558	1976
SD33	Pioneer Hybrid 3510	1979

C. M. Nagel, plant pathologist, developed 14 inbred lines from Fulton Yellow Dent. They were released through the Foundation Seed Stock Division, to commercial hybrid corn breeders throughout the cornbelt for use in developing new synthetic hybrids with various levels of resistance to root rot and with marked resistance to lodging, stalk breakage and ear droppage problems.

Inbred Designation	Source	Released
SDp2	Fulton Yellow Dent	1971
SDp232	Fulton Yellow Dent	1974
SDp236M	Fulton Yellow Dent	1974
SDp254	Fulton Yellow Dent	1974
SDp2A	Fulton Yellow Dent	1974
SDp309	(SDp236 x K63)	1975
SDp316W	(SDp236 x K63) white line	1975
SDp317W	(SDp236 x K63) white line	1975
SDp084	Fulton Yellow Dent	1976
SDp111	Fulton Yellow Dent	1976
SDp004	Fulton Yellow Dent	1978
SDp310	SDp236m x SDp309 ₂	1978
SDp311	SD236m x SDp309 ₂	1978
SDp312	SDp236m x SDp309 ₂	1978

Another 21 inbreds, developed by C. M. Nagel and John Jenison, were released by the Plant Science Department in 1976 to geneticists for use in developing stronger stalks. All were

developed from Fulton Yellow Dent.

SDp001, SDp014, SDp016, SDp022, SDp031, SDp034, SDp035, SDp037, SDp043, SDp060, SDp068, SDp096, SDp157, SDp211, SDp212, SDp214, SDp260, SDp262, SDp264, SDp275, and SDp282.

S. A. McCrory, long time Head of Horticulture, developed a score of sweet corn inbred lines, but no attempt has been made to include them here.

Corn Hybrids

A total of 16 hybrids were developed by the Agronomy Department. They were used by South Dakota farmers to plant hundreds of thousands of acres.

Hybrid Designation	Pedigree	Release Date
SD 204	(SD1 x SD4) (SD2 x SD5)	1941?
SD 210	(SD5R x B8) (SD26 x A509)	1958
SD 212	(SD1 x SD6) (SD2 x SD5)	1941?
SD 220	(SD26 x B8) (SD5 x SD48)	1953
SD 224	(SD1 x SD2) (SD5 x SD7)	1941?
SD 230	(SD26 x B8) (SD20 x SDp1)	1966
SD 240	(SD26 x B8) (OH56A x SDp1)	1961
SD 248	(SD5 x M14) SD15	1964
SD 250	(OH56A x B8) (M14 x SD5)	1954
SD 262	(OH56A x SD6) (M14 x SD5)	1951
SD 270	(OH56A x SD7) (M14 x SD5)	1951
SD 400	(WF9 x M14) (SD5 x SD7)	1944-45?
SD 420	(WF9 x OH56A) (OH45 x B8)	1957
SD 604	(WF9 x OH56A) (M14 x 0a420)	1955
SD 620	(WF9 x 38-11) (SD17 x OH41)	1961
SD 622	(WF9 x M14) (OH41 x OH43)	1957



Corn Committee 1967-1970 (standing) E. P. Adams, Ext. soil fert.; R. C. Ward, soil testing; F. C. Westin, co-chairman; J. Sanderson, farm management; (sitting) D. B. Shank, corn breeding; L. A. Derscheid, co-chairman; F. E. Shubeck, corn production (Photo in 1969).

CHAPTER XVII WHEAT

Wheat was planted at the Agricultural Experiment Station in the spring of 1888, the first crop season after the station was established. Sixteen varieties were planted including Kubanka durum which was imported from the northern provinces of Russia (Bul 11). Seven winter wheat varieties were planted that fall (Bul 17).

PERSONNEL

Several staff members who worked with wheat also worked with other small grains. However, D. G. Wells in 1962 became a full-time wheat breeder. He realized the potential for winter wheat and concentrated on it. He reasoned that spring wheat varieties adapted to South Dakota conditions were being produced by Minnesota and North Dakota. Though Nebraska and Kansas produced good winter wheat varieties, most of them would not withstand South Dakota winters except in southern counties. He embarked on a project to develop good winter hardy varieties that could be grown in central and northern counties.

In 1972 the South Dakota Crop Improvement Association secured a special appropriation from the legislature for a full-time spring wheat breeder. R. Pylman filled that position for 5 years and was succeeded by D. L. Keim.

Staff Members

Manley Champlin	1909-1911
J. D. Morrison	1912-1917
E. S. McFadden	1918-1920
Manley Champlin	1911-1920
J. E. Grafius	1942-1946
V. A. Dirks	1947-1961
D. G. Wells	1962-
R. Pylman	1972-1976
Harnek Sandhu	1975-1978
D. L. Keim	1977-
G. K. Hess	1978-

Graduate Students

Erhardt R. Hehn	M.S.	7/1/40-6/30/43
Donald L. Thompson	M.S.	4/1/47-3/20/49
Dan Chisholm	M.S.	1950-1952
Verlin Boeder	M.S.	1963-1965
Vanrat Sompow	----	1968-1969
Charles L. Lay	M.S.	1967-1969
Ray Wong	M.S.	1970-1972
Craig R. Cowley	M.S.	1972-1973
William Stegmeier	Ph.D.	1971-1973
Harnek S. Sandhu	Ph.D.	***-1978
Rama S. Kota	M.S.	1978-1980
D. K. Steiger	---	1978-

WHEAT IN SOUTH DAKOTA

Wheat production in South Dakota increased rapidly from 1891 to reach a peak of 4 million bushels in 1900 (Bul 268). At the turn of the century Eureka was the world's largest wheat shipping point.

However, wheat producers were constantly plagued with black stem rust, scab and other diseases. It was estimated that black stem rust caused a national loss of \$67 million in 1891 and annual losses of \$20 million during the early 1900s. In the northwest wheat producing states, rust reduced production by 30 million bushels and also reduced quality and market value. Losses were even greater during the "rusty" year of 1904 when South Dakota production was reduced 50% by rust (Bul 109).

Wheat production in South Dakota declined from 1902 to 1907, but climbed to a peak of 3.75 million acres in 1913, only to decline for another 13 years. This decline in wheat acreage was broken in 1919 (3,896,000 acres) in response to the demand created for wheat by World War I (Bul 268). At this time South Dakota ranked second to North Dakota in wheat production (Bul 201).

Though acreage was high, yields were low because of rust and scab. The years 1918 and 1919 proved to be poor wheat years because of scab. Rust was bad in 1916 and 1917 and practically ruined the crop in 1920 (Bul 201).

Durum varieties were resistant to prevalent races of stem rust. Acme, an amber durum variety developed at Highmore, became a popular variety and D-5, a red durum from North Dakota, found its way into northeastern counties (Bul 201).

Marquis was the leading hard red spring wheat variety but was badly damaged by rust and scab from 1917 to 1920. It then comprised 64% of the wheat acreage but dropped to 50% in 1922, while durum wheat increased from 23 to 40% of the acreage (Bul 201).

Because of increased production, durum prices began to decline. Wheat farmers were told that durums frequently outyielded other wheat by 25% and could be profitably produced until the market price of bread wheat exceeded that of durum by more than 25% (Bul 201).

During the early 1920s, it was said that wheat varieties resistant to rust or scab, or at least methods of successfully combating them would materially aid the wheat production. The Experiment Station was making every effort to

secure such information. It began testing earlier maturing Canadian varieties because it seemed that early varieties matured before being damaged by rust (Bul 201).

The acreage of winter wheat gradually increased until 1917 when only two-thirds of a rust damaged crop was harvested. Production had begun declining in 1916. Winter wheat did not survive at the Eureka Substation and winter killed 2 years out of 9 at the Highmore Substation. It produced 10 to 12 bushels per acre on summer fallow over a 5-year period at the Cottonwood Substation. Since it generally out-yielded spring wheat, it was felt that winter wheat might be profitably raised in areas receiving 25 or more inches of rainfall (Bul 200).

Wheat production reached an all time low in 1926, yet the farm value of wheat exceeded the combined values of oats, barley and rye by a substantial amount. Wheat ranked second to corn as the greatest grain crop. From 1920 to 1929 the farm value of wheat nearly equalled the combined values of oats, rye and flax (Bul 271).

Hope, the first rust-resistant bread wheat, was released in 1925. At that time South Dakota ranked second in the production of durum, third in the production of spring wheats and tenth in total wheat production, but yields were low and quality was declining (Bul 222). It was about this time that I remember seeing my father's clothing, the binder canvases and fly nets on the horses colored red by the uredospores of black stem rust after a day of harvesting wheat.

In 1927 durum wheat was an important crop in north central counties with production centered in Brown, Day, Marshall and Spink Counties. Hard red spring wheat was grown in all counties except a dozen southwestern and eight counties adjacent to the eastern border. Winter wheat was important in Lincoln, Clay, Union and Turner Counties and somewhat less important in Brookings, Lake, Minnehaha, Stanley, Tripp and Gregory (Bul 222).

During the 1930s Ceres and Thatcher became important spring wheat varieties. Of the 2.2 million acres planted in 1939, Ceres occupied over 1 million acres and Thatcher almost 3/4 million. Both were earlier than Marquis. Ceres was more tolerant of rust than Marquis and had greater resistance to the huge infestations of grasshoppers than either Marquis or Thatcher, but the latter had considerably more tolerance to rust. Though Hope was resistant to rust, its yield potential was low and only 3,000 acres were seeded in 1939 (Bul 342).

While the acreage of hard red spring wheat was increasing, the acreages of durum and win-

ter wheat were declining. Newer varieties of hard red spring wheat were yielding as much as durum varieties and market prices were higher for bread wheats. Though both types of spring wheat were produced in almost every county, the highest concentration of durum was in Day, Brown and Marshall Counties, with somewhat lower concentrations in Clark, Codington and Hamlin and still fewer acres in Edmunds, Spink, Roberts, Kingsbury, Lyman and Tripp. The bulk of the bread acreage was in North Central South Dakota with the highest concentrations in Campbell, Walworth and Spink counties and somewhat lower concentrations in other north central, northeastern and south central counties. Winter wheat acreages increased in southeastern counties but suffered severe damage from stem rust in 1937 and 1938. The best winter wheat growing area was west of the Missouri and south of the White River (Bul 342).

In 1939 the farm value of the wheat crop was approximately equal to the combined value of oats and barley and significantly exceeded the value of any other small grain crop (Bul 342).

During the 1940s the varieties derived from Hope and H-44 (Pilot, Rival, Mida, Cadet, Renown and Rushmore) were available. The acreage of hard red spring wheat climbed to an all-time high in 1949.

Durum varieties were resistant to prevalent races of black stem rust until 1950 when Race 15 B became common. It developed into an epidemic in 1952. It reduced yields 50 to 70% and acreage reductions followed. Four varieties resistant to this race were released by North Dakota in 1955. As seed became available, acreages increased but never reached the 1949 to 1952 level which was only about half of the 1927 to 1930 acreage.

Likewise, winter wheat varieties were tolerant to prevalent races of black stem rust. However, race 56 struck in 1962 causing a loss of about \$25 million to winter wheat producers in the state. As with durum, acreage reduction followed. However, with the release of Hume in 1965 and several Nebraska varieties that were resistant to this race, more acres were seeded and higher yields obtained.

During the 1960s acreage controls were imposed on wheat and feed grains by the federal Wheat Stabilization and Feed Grain programs. When restrictions were removed in 1973, about 1.25 million acres of rangeland were plowed and the acreage of bread wheats increased 25 to 30% in 1974 while 85% more durum was planted. Acreage restrictions were once again imposed in 1978. Fewer acres of the bread wheats were planted, but durum prices were relatively good and its acreage increased.

VARIETY DEVELOPMENT AND DISTRIBUTION

SDSU staff and alumni made major contributions to the world's wheat crop by the development or introduction of Iumillo durum, Yaroslav emmer, Kubanka durum, Hope HRS wheat, and Norlin-10 semi-dwarf wheat. All these varieties provided germ plasm for the present day world wheat crop.

N. E. Hansen, on his 1897-1898 foreign expedition, obtained seed of six strains of durum wheat from Kubanka in Central Asia. Germ plasm from Kubanka has appeared in durum varieties for over a half century.

During the heavy stem rust infections of 1904 and 1905, John S. Cole observed that durum from Bulgaria, Spain and Italy were very susceptible to the disease except for No. 1736 from Italy. It was later named Iumillo, probably for its place of origin.

At the same time he noticed that four strains of emmer were resistant to blackstem rust and produced about 40 bushels per acre--10 times as much as those infected by the rust. One was named Yaroslav, probably for its place of origin northeast of Moscow.

Yaroslav emmer in 1916 was crossed with several of the leading hard red spring wheat varieties by Edgar S. McFadden. One Yaroslav-Marquis cross produced 100 seeds. At Highmore McFadden selected six lines, including H-44 and H-49. The latter became the variety Hope. It was resistant to blackstem rust, leaf rust, loose smut and stinking smut.

Minnesota plant breeders crossed Iumillo durum with Marquis to develop the hard red spring wheat variety Marquillo. Resistant to stem rust, it was used to breed several wheat varieties. One of them was Thatcher which was a leading spring wheat variety in the Northern Great Plains during the 1930s and early 1940s. Thatcher was crossed with other varieties to produce new ones.

Because Thatcher was susceptible to leaf rust, it was gradually replaced by Hope derivatives; Pilot, Rival, Mida, Cadet and Renown. Rushmore, the first hard red spring wheat developed in South Dakota, came from a cross between Thatcher and Rival. It contained germ plasm from both Iumillo durum and Yaroslav emmer. Between 1939 and 1945 over 15 million acres of Hope derivatives were planted in Northern United States and Canada.

Minnesotan's crossed Hope with a winter wheat Minturki to produce Minter a rust-resistant winter wheat. J. E. Grafius in 1945 crossed Minter with several other varieties. One of the surviving lines, selected in 1958,

by V. A. Dirks was developed, tested, released and named Hume by D. G. Wells in 1965. Now the Hope genes for rust resistance were in winter wheat.

Semi-dwarf wheat was introduced into North America by another South Dakotan, S. Cecil Salmon, who graduated from SDSC in 1907. In 1945 while serving as a consultant to the U. S. Army in Japan, he became interested in the short-strawed, high-yielding wheat that the Japanese had developed from wheat obtained in Italy. Salmon brought seed of Norin-10 to the U. S.

The cross of Norin 10 x Brevor was mated in 1954 with Mexican wheat varieties by Norman E. Borlaug and associates of the Rockefeller Foundation at Obergon, Mexico to produce many semi-dwarf varieties.

During the 1970s hundreds of thousands of acres in the United States, Canada and Mexico were planted to semi-dwarf wheat varieties--all were descendants of Norin-10 and most had the Hope-type of rust resistance.

Blackstem rust had not been a serious problem for a decade and a half, however, a new problem developed in 1978--an infestation of Hessian flies.

Wheat breeders had developed winter wheat varieties resistant to the pest, but it had not been a problem in spring wheat and resistant varieties of that crop had not been developed. With the assistance of sizeable grants from the South Dakota Wheat Commission and the USDA and full cooperation of the USDA Hessian fly laboratory in Kansas, a crash program to develop a Hessian fly-resistant spring wheat variety was initiated by Donald L. Keim, spring wheat breeder; George W. Buchenau, Plant Pathologist; David D. Walgenbach, Entomologist; and their assistants in the Plant Science Department.

By growing two crops a year they were able to make selections from four crops. They kept three lines in which Dawn, a semi-dwarf winter wheat, was the pollen parent.

Two lines were released in 1981 to plant breeders for use as a source of Hessian fly resistance. The third line is being increased for possible release in 1983 as the first Hessian fly resistant hard red spring wheat variety. All three lines inherited genes from Norin-10 through Dawn and genes of Hope through the female parents.

Acme Durum Wheat

Manley Champlin used the pedigree breeding technique to develop Acme durum. In 1909, he

selected 60 heads from each of two strains of Kubanka, imported from Russia. The next year 20 seeds from each head were seeded 3 inches apart, in separate 5-foot rows spaced 1 foot apart, and grown with Kubanka as a check. Rows were observed closely, and seed from the most promising selections was saved for further testing (Bul 194).

Seed from each spike was planted in a separate head row. Seed from the most promising rows was saved and sown in larger plots. By the end of the fourth year, all but a few of the most promising selections had been discarded. Rows saved were included in a variety test where they were compared with standard varieties. Some were dropped each year. At the end of the 1915 growing season, selection 7 was increased and named Acme (Bul 114). It was placed in Standard Variety Tests at Brookings in 1916, and at the Cottonwood and Eureka Substations in 1918.

In 1916 E. S. McFadden sent one bushel of seed to each of two farmers--his father at Webster and E. L. Bolland near Pierpoint.

Seed was sold to farmers in six counties in 1917 and in 11 more counties in 1918. Yield comparisons were made with other varieties grown under similar conditions. Though some cooperative tests were continued in 1919, most farmers had enough seed to plant their entire acreage (Bul 194).

Since it had proven to be resistant to the rust epidemics of 1917 and 1918, most farmers did not seed other varieties for comparison. However, 47 farmers in Clark County each planted a bushel of Acme beside another variety for comparison (Bul 194).

Milling and baking tests were conducted on grain produced at Highmore and Brookings in 1916, 1918 and 1919. Since Acme was a high yielding variety with superior stem rust resistance and satisfactory quality, it was recommended for production in 1921 (Bul 194).

Hope Wheat

Edgar S. McFadden changed the plant breeding techniques for self-pollinated crops. He initiated the technique of cross breeding and produced the first hard spring wheat variety in South Dakota. Excerpts from two speeches tell how he developed Hope wheat. In 1926, he gave "Confessions of a Plant Breeder" to the Kiwanis Club in Webster, and on March 27, 1928, he addressed the first Hard Red Wheat Conference in Fargo, North Dakota. Copies of both speeches were provided by D. G. Wells.

E. S. McFadden

"I had spent 3 years in the desert southwest and returned to South Dakota in time to witness the big drought of June 1911, which was followed by a rust epidemic. It seemed that a drought like 1911 or a rust epidemic like the one in 1904 could cause a nationwide and possibly worldwide famine. With these ideas in mind, I started for State College for the purpose of learning about botany, field crops and plant diseases to learn how to develop drought- and disease-resistant crops.

"During the summer of 1913 I was a field assistant at the Experiment Station and in 1915 the Agronomy Department hired me as a plant breeder. I held that position until the spring of 1918.

"Yaroslav emmer possessed a high degree of resistance to several diseases and several agronomic characteristics which would be of great value in hard spring wheat. In 1916 several crosses between Yaroslav emmer and our leading commercial varieties were attempted. A single plant resulted from the cross in which Marquis wheat was the pollen parent and Yaroslav emmer the seed parent. This plant produced a great number of stems which bore spikes. All the spikes showed more or less sterility, but over 100 seeds were obtained.

"In the spring of 1918 I obtained a position in charge of cereal investigations at the Highmore Experiment Station. The USDA paid my salary while the Agronomy Department supplied the land, buildings, etc. From the seed obtained a year earlier, approximately 100 plants were grown in 1918. None of the plants appeared very promising and it appeared that it would be impossible to make any progress by systematic selection. I decided to harvest and thresh the material in bulk and grow it as a "mixed population" for several generations to give promising types a chance to make their appearance. Accordingly the material was planted, harvested and threshed in bulk at Highmore in 1919. It was a bad rust year and plants that did not possess a high degree of resistance to rust produced shrunken seed which made it possible to separate the resistant and susceptible types by mechanical means. The material was threshed with a plot thresher and run over a small clipper seed cleaner and an Emerson Kicker.

"Only a fraction of one percent of the original bulk seed remained, but between four and five thousand plants were grown from it in 1920. About 100 of the more promising plants were selected and tagged for further study. All of these selections, except six which

appeared to be true wheats, were eventually discarded.

"In June 1920 I received word from the USDA that a big cut in its appropriation made it necessary to withdraw its support from several western state experiment stations, including Highmore. I could have been transferred to a higher paying USDA position in the east or taken a teaching position in the Agronomy Department, but I had started out 10 years before to develop drought-and disease-resistant crops for northwestern conditions. I had no intentions of being diverted from my course. Accordingly, I returned to my old home farm in Day County in the fall of 1920 and brought much of the more promising plant material along with me.

"For 5 years the work was conducted on my own grounds and wholly on my own resources which were sorely taxed at times.

"In the spring of 1921, the six Marquis-Yaroslav selections were planted in progeny rows on my farm near Webster. All of those selections remained entirely free of stem rust and developed only a trace of leaf rust; but both Marquis and Kota, which were used as checks, developed considerable rust. The more promising of the new selections were reselected for kernel type and grown in progeny rows in 1922. On July 15, 1922, my farm was visited by a severe hail storm. I was greatly surprised to find that although the check rows of Marquis were almost completely destroyed, several Marquis-Yaroslav selections were practically uninjured as a result of strong chaff and flexible stems inherited from emmer.

"Since none of the progeny of the selections grown in 1922 were entirely uniform, new selections were made from the rows that survived the hail. They were grown in progeny rows in 1923. A severe epidemic of stem rust developed in July 1923. These selections were entirely free from all traces of stem rust; whereas, check rows of Marquis carried 100% infection. They did, however, suffer from root rot and black chaff. About 60 plants that appeared less susceptible to these diseases were selected and grown in progeny rows in 1924.

"Another desirable characteristic of the Marquis-Yaroslav selections was their high degree of resistance to both loose and stinking smut. Several attempts to infect them with these diseases met with complete failure. It is not known where they obtained their resistance since the emmer parent was particularly susceptible to stinking smut, and Marquis was not highly resistant to either smut. Apparently they came by their resistance to smuts in much the same way that

Columbus discovered America--largely by accident.

"Several natural crosses between the Marquis-Yaroslav selections and other wheats grown in my nursery were found in 1923. Progeny of these crosses were grown in 1924 and their progeny were grown in 1925. A study of this material showed that there was no linkage between susceptibility of root rot and black chaff. I was convinced that the Marquis-Yaroslav selections possessed great value for breeding purposes. They could be crossed with other wheats to produce varieties that were resistant to rust and possessed other desirable qualities of the other wheat parent. Accordingly, what appeared to be the most promising of the selections was given the name Hope and distributed to several experiment stations within the spring wheat area for use as a parent in their breeding program.

"It must be realized that rust resistance alone does not make wheat of any great value. The ultimate value of any variety of bread wheat is determined by its milling and baking qualities. A seed sample of the selection named Hope, tested at State College in 1924, contained 15.84% protein. Other samples tested in 1925 by Bliss and Wilhoit Chemical laboratories in Minneapolis contained 16.65% protein and 13.27% gluten. This was very promising because most Marquis grown in Day County that year showed a protein content of about 12%.

Rushmore Spring Wheat

Almost a quarter of a century passed before the second hard spring wheat variety developed in South Dakota. In 1937, S. P. Swenson crossed Thatcher, a Minnesota variety, with Rival, a descendant of Hope (Bul 394). Swenson left the state in 1941 and J. E. Grafius finished the development and evaluation of the



E.R. Hehn & J.E. Grafius checking plots--1942.

variety. In 1949 the South Dakota Seed Stock Division released 4,800 bushels of Rushmore to members of the South Dakota Crop Improvement Association (JW-57). Though the method of breeding was the same as that used by McFadden, the system of distribution had greatly improved.

Hume Winter Wheat



V. A. Dirks making wheat crosses in greenhouse.

From the time the original cross is made, a minimum of 8 to 10 years elapse before it is actually released as Foundation seed. It then takes farmers several years to build up the supply to a point where any sizeable acreage of the crop can be planted.

Though the length of time to develop a variety may be longer than indicated under ordinary circumstances, the release of a variety is almost always delayed by a change in personnel. Hume wheat is a good example.



D. G. Wells emasculating winter wheat.

Hume winter wheat was the first winter wheat developed and released in South Dakota with resistance to stem rust tracing back to the pioneering work of McFadden. It was deve-

loped from crosses involving Minter, a Hope derivative, made in 1945 by J. E. Grafius and further chosen from among surviving lines in 1958 by V. A. Dirk (Wells).

Then D. G. Wells completed the work for verification of Hume's good qualities, purification and increase. When Hume was released to growers in 1965, it was named for A. N. Hume, the first head of the SDSU Agronomy Department (Wells).

In the meantime a race of stem rust to which Hume was resistant caused a \$25 million loss to wheat growers in 1962. If Hume had been developed and released in 10 years time, there could have been enough acreage of the variety to greatly diminish the losses sustained.

Counter Attack On Hessians

Hessian fly is an insect thought to have been imported by Hessian soldiers during the Revolutionary War. The King of Hesse-Kassel in Germany rented them to the British and they supposedly brought the insect in hay and straw to be used for their horses. The insect was a common pest in the winter wheat producing states of Kansas and Oklahoma, and wheat breeders had developed winter wheat varieties that were tolerant to it.

Hessian flies were observed from time to time on spring wheat in South Dakota and a small infestation developed in Grant County during the mid-1950s. However, it did cause serious damage and spring wheat breeders ignored it. They continued to breed for disease resistance, yield and quality.

However, an outbreak of Hessian flies, centered in Brown, Day and Spink counties and extending over 375,000 acres in the northern half of East River caused an estimated damage of \$30 million to spring wheat in 1978. The crisis sent SDSU's wheat breeders in action. They embarked on a program to breed a variety of spring wheat that would be unharmed by the larvae of the Hessian fly.

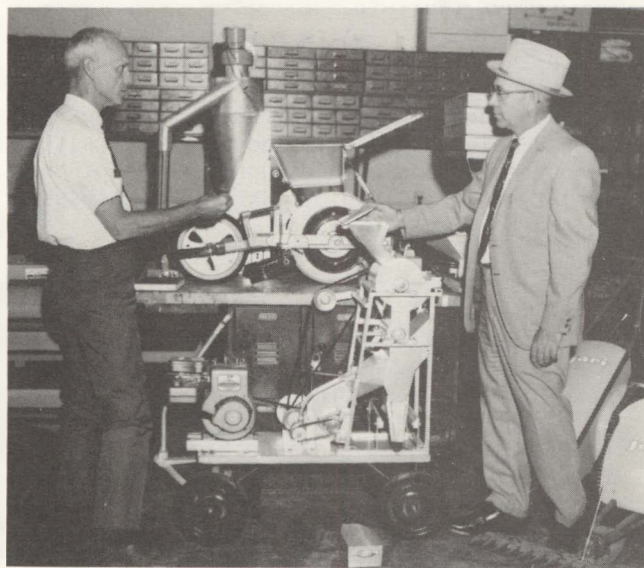
The program was summarized by Jerry Leslie, Ag. Information Specialist at SDSU in the 1980 summer edition of *Farm and Home Research*.

Jerry Leslie

They expect to have a resistant variety of spring wheat in the hands of farmers by 1983 or 1984 if all things go well, according to Don Keim, spring wheat breeder.

Keim searched the available spring wheat germ plasm and learned that there weren't any resistant varieties. So wheat breeders looked

to their breeding nursery for populations which had been crossed with winter wheat varieties for other reasons. They found several crosses of spring wheat with resistant winter wheat varieties Vona, Linden, and Co. 701733. Keim and staff selected from these populations and sent them to Kansas State University for screening for Hessian fly resistance.



D. G. Wells discussing head thresher in 1968.

Dr. Jim Hatchett, USDA entomologist at KSU, screened 14,000 spring wheat plants in the fall of 1978 by growing them in flats and putting the fly on them. The flies laid their eggs, the eggs hatched and infested the plants with larvae. The plants that survived were considered resistant. The others were discarded.

Hatchett found 1,050 plants that were resistant. Keim and crew grew them, harvested the seed and planted it in the field in 1979. Each head produced seed for a row of 20 to 50 plants. Of these 1,050 rows Keim selected 30 rows as pure lines. Seed from the 30 pure lines was sent to Mexico for increasing during the winter. Extra seed of the same 30 lines was also sent back to KSU and screened a second time for Hessian fly resistance. Of those 30 lines, nine were considered homozygous (identical in hereditary characteristics) and were considered for varieties. In 1980, SDSU yield tested the seed produced in Mexico from these nine lines at several places around the state including the counties of Brown and Day.

At the same time that the wheat breeders were pushing on toward a new resistant variety, they crossed some more varieties of spring and winter wheat, looking for stronger

sources of resistance. This germ plasm would go through the same detailed process of becoming a resistant variety and would become available in later years.

The time of breeding a resistant variety was cut substantially by using the winters to increase the seed at the International Maize and Wheat Improvement Center (CIMMYT) at Ciudad Obregon, Sonora, Mexico, which is sponsored by the USDA and the Crop Quality Council in Minneapolis. A release in the spring of 1983 will be less than 5 years from the time the original cross was made.

On the SDSU staff are Dr. Keim; Dr. George Buchenau, Plant Pathologist; Dr. David Walgenbach, Survey Entomologist; Kathy Sellers, Ag Research Technician; and Debra Steiger and Greg Hess, Assistants in Plant Science. Also involved were Dr. J. H. Hatchett, USDA researcher on the Hessian fly at KSU, staff with the Crop Quality Council and staff with the Wheat Quality Lab at North Dakota State University.



Rod rows in wheat breeding nursery.

Much of the funding for the project came from the South Dakota Wheat Commission. The Wheat Commission initially funded the project for \$13,300, and then more recently agreed to continue the grant for 3 more years. Keim and crew also are getting a USDA specific cooperative agreement for 3 years in the amount of \$21,000.

If SDSU can produce a resistant variety which also has the qualities of good yield, rust resistance and good quality for bread flour, the insect will not be a threat to farmers who use that variety.

After Leslie wrote this article, a second crop was grown in Mexico and three lines, in which Dawn, a semi dwarf winter wheat was the pollen parent, were kept.

James and Coteau, standard height spring wheats, were parents of SD 8011 and SD 8015. Though neither line was homozygous for plant

height, they were released the spring of 1981 to other plant breeders to be used as a source of Hessian fly resistance in their breeding programs much like Hope and Iumillo had been used a half century earlier.

Eureka was the female parent of the third line which is being tested for possible release as a variety. If it passes all the tests. The first Hessian fly-resistant hard red spring wheat variety may be released in 1983.

Intergeneric Crosses

Most varieties have been developed by crossing two or more varieties in the same species. Hope wheat, an inter-specific cross, was developed by crossing two species in the same genus.

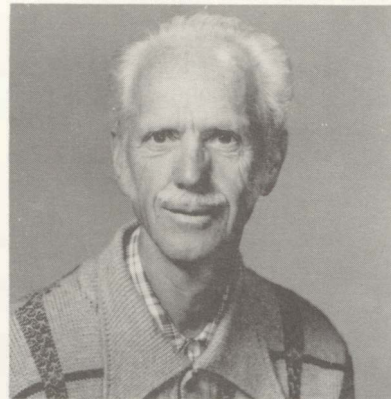
"There are several other phases of wheat breeding that I am investigating at present," E. S. McFadden said in 1926. "One of these is the possibility of crossing wheat with certain of our native prairie grasses such as the wheat-grasses, which are close relatives of our cultivated wheats. At least three well defined species are native to this part of South Dakota. Slender wheatgrass has been domesticated as a forage crop and is grown to some extent in this (Day) county. Western wheatgrass is a dominant species over large areas of the western part of the Dakotas. This species is a long-lived perennial, is extremely winter hardy and highly resistant to drought, heat, frost, and alkali. If these characters, especially the perennial nature, were bred into our cultivated wheats, the farmer could then seed his fields down to "perennial wheat", move to the big city and go into the industries, returning to his farm once a year for a 2-week vacation in the harvest field. And believe me, if there is anything that this part of the country needs worse than "a good five-cent cigar", it is a profitable, sod-forming, perennial crop that will hold down our top soil."

"Immunity from streak mosaic occurring in intermediate wheatgrass has been the subject of intense breeding research in South Dakota since 1963," Wells said in 1980. "Five lines were developed and registered as germ plasm having unlike portions of a chromosome from wheatgrass bearing a gene for immunity. All were otherwise Centurk in type except for some negative influences on seed yield and other traits from wheatgrass. Breeding and selection will adapt the immune germ plasm in time to conditions in the Great Plains resulting in high performing immune varieties."

Objectives of the 1970s

The objective in winter wheat breeding was to select early, especially hardy, medium to

short-strawed lines having resistance to both stem and leaf rust, good milling and baking qualities and of good yield and test weight. The success of such a program should enable growers to use fall-sown wheat ever farther northward and eastward in this state (Wells).



D. G. Wells

Breeders and geneticists assume that such goals are possible to achieve. But the desired combination of superior qualities in a new very hardy strain had not been found by 1979, either in the upper Midwest or in the great winter wheat region of Eurasia. We live with the possibility that such a goal can be achieved only over a long span of time and perhaps with improved techniques (Wells).

Protein content of wheat has been important in determining the suitability of wheat for bread flour. Past and current research has shown the protein content of crops can be increased by nitrogen fertilization. In addition, a strongly dominant gene for high protein in winter wheat has been found in a South Dakota experimental line named Hand which also is highly resistant to rust and particularly hardy. This experimental wheat line probably will be a parent of future high protein commercial winter wheat varieties (Wells).

WHEAT VARIETIES DEVELOPED IN SOUTH DAKOTA

<u>Variety</u>	<u>Crop</u>	<u>Released</u>
Acme	durum	1916
Rushmore	spring	1948
Hume	winter	1965
Winoka	winter	1968
Bronze	winter	1972
Gent	winter	1974
Eureka	spring	1978
James	spring	1980

STATE ACREAGE AND PRODUCTION

Wheat acreage was influenced by disease epidemics, market price, government programs and by the availability of high producing

varieties. Hard red spring wheat acreage fluctuated from 3.2 million in 1919 to 2.3 million in 1940, 1.7 million in 1960 and 2.3 million in 1978. Average state yields increased from 7.7 bushels per acre in 1919 to 10-year average yields of 12.5 in the 1940s, 17.8 in the 1960s and 24 in 1978.

Durum acreages for the same years were 565,000, 619,000, 119,000 and 195,000 acres.

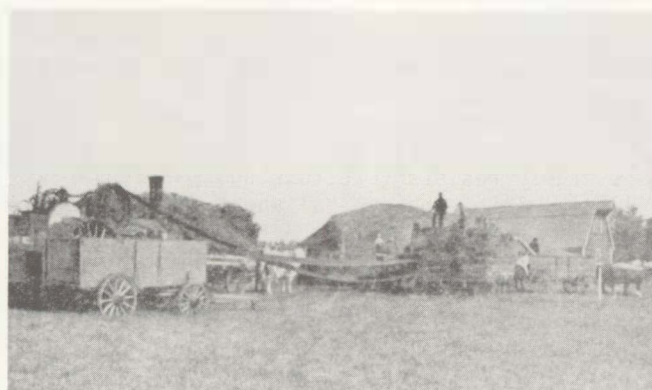
Yields for the same periods were 9.8, 13.1, 20, and 20 bushels per acre.

Similar figures for winter wheat were 132,000, 161,000, 708,000 and 1,080,000 acres and 10, 15.2, 24.5 and 26 bushels.

In 1975 South Dakota ranked third among the states in durum production, fourth in spring wheat production and sixteenth in winter wheat production.



Harvesting wheat with binders in mid-1920s.



Threshing spring wheat bundles in mid-1920s.



Another wheat threshing scene in mid-1920s.

CHAPTER XVIII OTHER SMALL GRAINS

Small grains have been the object of research in South Dakota since the beginning of the Agricultural Experiment Station. The station was established in 1887, land was purchased on July 25 and crops were planted the next spring.

Luther Foster, Agriculturist, planted 19 varieties of oats, and 13 varieties of barley (Bul 11). Black and white hullless barleys were sown in 1890 (Bul 21). Two varieties of emmer, sometimes called speltz, were included in variety trials at the Highmore Substation in 1903 (Bul 84).

Oats, barley, rye and emmer were included in long-time crop rotations initiated at the Cottonwood, Highmore and Eureka Substations in 1912 (Bul 272 & 312, Cir 103). Barley, oats and rye were in rotations established at the Vivian Substation in 1920 (Bul 253).

PERSONNEL

Staff Members

Manley Champlin	1909-1911	(Cereals)*
J. D. Morrison	1912-1917	(Cereals)*
E. S. McFadden	1918 1920	(Cereals)*
Manley Champlin	1911-1920	(Crops)
A. T. Evans	1922- ?	(Path.)
George Janssen	1922- ?	(Crops)
E. W. Hardies	1923-1928	(Crops)
C. J. Franzke	1924-1928	(Crops)
K. H. W. Klages	1928-1935	(Grain)
S. P. Swenson	1936-1941	(Grain)
J. E. Grafius	1942-1953	(Grain)
V. A. Dirks	1947-1961	(W,R)
D. D. Harpstead	1953-1961	(O,B,R,F)**
P. B. Price	1957-	(USDA,B)
R. Albrechtsen	1962-1969	(O,R,F)
D. L. Reeves	1970-	(O,R,F)
C. W. Wirth	1977-	

Graduate Students

Walter N. Nelson	M.S.	1946-1948
James Stone	M.S.	1950-1952
Tony J. Ganje	M.S.	1957-1959
Norman E. Williams	M.S.	1957-1959
Neil Widstrom	Ph.D.	1960-1963
Jong Teng	M.S.	1961-1963
Joseph J. Bonnemann	M.S.	***-1954;
Robert Yung Yen Yeh	M.S.	1965-1967
Sheria Chaio-Tong Chang	M.S.	1967-1969
Leroy A. Spilde	M.S.	1968-1970
Emanuel Kidane	M.S.	1970-1972
Erol Oral	M.S.	1970-1972

James L. Heilman	M.S.	1972-1974
David G. Hanson	M.S.	9/72-12/74
Harnek S. Sandhu	Ph.D.	1975-1978
Charles W. Wirth	M.S.	1978-

* USDA - located at Highmore Substation

** O-oats, B-barley, R-rye, F-flax

***Staff member while in graduate school

OATS

Oats was always a good feed for horses and for producing growth in young livestock as more acres of the state were put under cultivation.

From 1920 to 1924 South Dakota produced an average of 76 million bushels annually and ranked fifth in oats production in the United States. Though fewer acres were planted to oats than wheat, more than twice as many bushels of oats were produced (Bul 230). However, during this same period it did not compare favorably with barley in pounds of grain produced per acre or in economic value.



H. Sauer and V. A. Dirks in Waubay oats evaluation plots in 1952.

Though horses were replaced by tractors in the 1940s, the acreage of oats continued to increase until it reached a peak of 4 million acres during the mid-1950s. It then declined to less than 3 million acres in 1954 and remained below that point until 1974.

Swedish Select, a mid-season variety, was the best yielding variety during the early 1900s, however, it was soon replaced by Cole, an early maturing selection made at Highmore. Since that time early maturing varieties have

been grown in southern counties, mid-season in northern areas and a few late maturing varieties have been satisfactory in northeastern counties.



R. Albrechtsen examining 1964 oats crosses.

South Dakota ranked second in oats production in the United States in 1978 and was one of the top three states that produced oats used for human consumption.

BARLEY P. B. Price

Barley has been an important part of the agricultural scene since the settlement of this state a century ago.



P. B. Price checking barley for plump kernels.

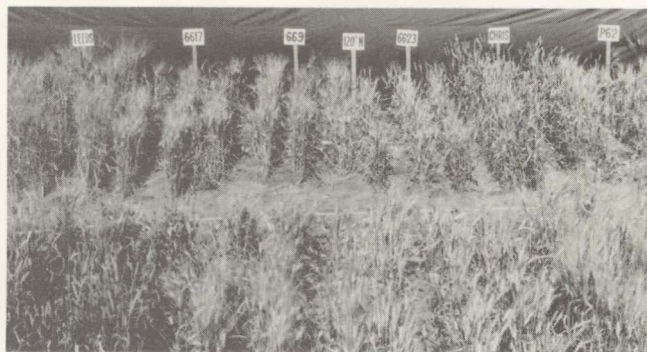
In 1880 about a third of a million acres were planted to barley. It increased in popu-

larity until 1942 when almost 2.5 million acres were seeded to barley--more than 20% of all cereal acreage in the state.



J.E. Grafius in 1947 Feebar barley increase plots.

Around 1944 barley acreage began to decline. The decline can be attributed to several factors. The barley varieties in production between 1880 and 1960 were mostly roughawned. They were ill-adapted to the edaphic and climatic conditions. They were principally selections of the Manchurian barleys which had been introduced into this country by European immigrants or grain traders. The varieties Manchuria, Odessa, Smyrna, Trebi and White Smyrna were familiar names to the barley growers in the early years of the 20th century. These varieties were replaced by other rough-awned varieties Feebar, Kindred, Traill, and Trophy. Rough-awned barley varieties had morphological and physiological characteristics which made them less heat- and drought-tolerant than smooth-awned varieties.



Head rows for barley.

The weak-strawed characteristic of the older rough-awned varieties also contributed to the decline in acreage. Barley was a relatively poor feeder of mineral nutrients and required applications of nitrogen, phosphorus and potassium in soils that did not require fertilization for oats production.

When old varieties were seeded on mineral deficient ground, grain yields were low. When fertility was improved by the application of manure or inorganic fertilizers, plants often lodged. Lodging created a tight canopy over the ground which raised the humidity near ground level and promoted the rapid spread of bacterial and fungal diseases. The combination of downed and diseased plants resulted in lower yields of poor quality grain. After 1942 the popularity of barley declined rapidly.

For these reasons most of the barley acreage in South Dakota after 1960 was seeded to smooth-awned varieties. Included in this group were the varieties Conquest, Larker, Liberty, Morex, Prilar, Primus and Primus II.

Another factor was government control of production. Barley, corn and grain sorghum were the crops included in the federal Feed Grain program implemented in 1963. Acreage restrictions reduced the number of acres that a farmer could plant to feed grains. Many producers reduced their "feed grain" acreage by planting less barley--acreage dropped to a low of 222,000 acres in 1966.

Then in 1966 Primus barley was released, and later Primus II was on the list of recommended varieties. These varieties and Larker from North Dakota were better suited to South Dakota conditions than any available before. After 1965 barley acreage again increased steadily to the 680,000 acres planted in 1977.

RYE

Rye was used at the Experiment Station almost from the beginning, but there was no concerted effort to improve the crop.

Producers grew this fall-seeded winter hardy crop for several uses. It was a competitive crop and aided in weed control. It could be planted in the fall, helping to distribute the workload on the farm. It could be used as late-fall or early spring pasture, as a green manure or cover crop, as hog feed or as a cash crop.

The acreage in the state gradually increased to a peak of 600,000 acres in 1922, declined for a decade then gradually built up during the drought to an all-time high of 1.2 million acres in 1939. It then dropped off to 300,000 acres in 1953 and then ranged between 200 and 400 thousand acres for more than a quarter of a century.

EMMER

Emmer was first grown in South Dakota by Russian immigrants who, doubtlessly, brought

it with them from the Fatherland. They called it speltz. It was later again introduced by the USDA. In the northwestern part of the state around the turn of the century, it was grown about as commonly as oats or barley, which it exceeded in drought resistance (Bul 71).

Emmer was a member of the wheat genus but did not thresh free of its glumes like other wheat species. It carried about 25% hull compared to 28% for oats and 10% for barley (Bul 179).

E. C. Chilcott compared emmer and barley as feed for fattening lambs during the winter of 1900-1901. Lambs fed barley gained 1.5 times as much as those fed emmer during a 12-week period. Though it appeared that emmer would be worth two-thirds as much as barley, the gains did not cover the cost of feed, labor and interest on investment. Those fed barley produced a net profit of \$4.41 per lot of twelve (Bul 71).

In 1904 there were 2.9 million bushels of emmer raised in the state compared to 5.6 million of corn. Though it was grown in all but three West River counties, two-thirds of the crop was raised east of the Missouri River and north of a line between Brookings and Pierre (Bul 100).

Emmer was planted at the Experiment Station in 1902 (Bul 179). It was compared with corn, oats and millet for baby beef production in 1905 by J. W. Wilson and H. G. Skinner. Calves were fed various rations until they were almost 2 years old and sold in separate lots on the Chicago market. The prices per hundred pounds were \$6.25 for those fed corn, \$6.00 for oats, \$5.75 for millet and \$5.85 for emmer. While on pasture, those fed emmer gained 112 more pounds than those on corn, but during the fattening period, average daily gains were 1.47 for millet, 1.69 for emmer, 1.76 for oats and 1.84 for corn. Feeding value was 26 cents per bushel (32 lb) for oats, 33 cents (45 lb) for emmer, 38 cents (60 lb) for millet and 47 cents (56 lb) for corn (Bul 97).

A year later Wilson and Skinner compared emmer with corn for beef and pork production. Steers fed ground emmer gained 0.24 pound per day more than those fed whole grain. A pound of corn was equal to 1.25 pounds of emmer for feeding steers. Pounds required for a gain on swine were 5.27 for a corn-emmer mixture, 7.71 for whole emmer and 8.26 for ground emmer (Bul 100).

Emmer, oats, barley, durum and winter wheat, and winter rye were compared in crop rotations at Brookings and each of the sub-

stations. In 1918 Manley Champlin concluded that emmer would not be as valuable as oats or barley unless it contained higher food value. It produced only a very little more than winter rye, which was far more valuable pound for pound. When compared with wheat, the slightly larger yield of emmer, when considered on a hullless basis, would not offset the better milling quality of wheat. Emmer was considered to be the least valuable of the small grain crops. The only reason for growing it was that it added one crop to the list and gave a greater chance of versification (Bul 179).

VARIETY DEVELOPMENT AND RELEASE

Experimental work before 1905 was aimed at determining what kinds of crops were adapted to South Dakota and comparing the existing varieties. However, in 1905 a number of experiments in the selecting and breeding of plants were initiated for crops including millets, forages, corn and sorghum (Bul 96). Work with Cole oats was already in progress.

Pedigree Breeding

This breeding procedure is the same as that used for the development of Acme durum. It is assumed that Cole oats selected from Swedish Select, Ace barley selected from White Smyrna, and Fowlds hullless oats were developed in the same manner.

Cross Breeding

While at Highmore from 1918 to 1920, McFadden made many crosses involving barley varieties Odessa, Manchuria, Lion, Coast and Club Mariot. From the double-cross (Odessa x Club Mariot) x (Lion x Manchuria) came the variety Dryland, the second barley variety developed in South Dakota. The cross of Dryland x Peatland became Plains, the fourth barley variety to be released from the South Dakota Agricultural Experiment Station.

In the technique of hybridization, the male organs and the beards, if any, were removed from each of several flowers on the spike or oat panicle, leaving the pistils exposed. Pollen grains were extracted from the anthers of another variety nearing anthesis and dusted on the exposed pistils. The pollinated spike or panicle was covered with a small sack to prevent contamination from any other pollen source.

All varieties released since the mid-1920s, except for perhaps Nakota hullless oats, were bred in this manner. Hybridization has the advantage of incorporating the good characteristics of two or more varieties into one. A variety may inherit stem rust resistance

from one parent, leaf or crown rust resistance from another, drought resistance from a third and high protein content or quality from still a fourth parent.

Plant breeders make thousands of crosses. Crossing is done in the greenhouse during the winter and in the field during the summer. Seed from individual heads is sown in separate short head rows and the plants observed for diseases, agronomic characteristics and other traits. Individual plants may be selected and planted in pedigree rows or crossed with plants of a different parentage. Seed from them will eventually be planted in rod rows and tested for yield. When enough seed of selected lines is available, it is subjected to quality tests and the poor lines discarded.

Though a plant breeder may start with 10,000 selections, only two or three may be kept for increasing. From a peck to a few bushels of breeders seed are given to the Foundation Seed Stock Division which multiplies the seed until there are 500 to 5000 bushels available. One or more of these lines may be discarded during the increase period. If the variety is released, Foundation Seed is sold to Crop Improvement members who produce Registered seed. This seed is planted to produce Certified seed and may be sown by the grower who produced it or sold to another grower.

Techniques and methods of breeding have improved over the years, yet growing a crop in actual South Dakota conditions still requires one year. Scientists stepped up this process by using greenhouse facilities and by sending seed to Mexico, Arizona and other areas where a crop can be produced during the winter months.

Objectives of the 1970s

Oat protein and fat content probably can be increased about 3% with the research lines available in 1979, but the amount produced per acre was more important than the percentage. Spear oats, released in 1975, was one of three very high protein oats available in the U.S. While tests with livestock continue, Spear continues to show promise for feeding, especially to pigs. It offered South Dakota farmers the advantage of cutting down on the amount of expensive supplemental protein they needed to buy (Reeves).

The feed value of oat grain for livestock was only one aspect of all the traits that plant breeders need to consider. They note grain size, shape, color, heat tolerance, marketing qualities, and harvesting capabilities. They monitor total yield, disease

and insect resistance, and use of soil moisture and soil type (Reeves).

Barley is a dual purpose crop. It is a nutritious livestock feed and the principal grain used in the production of malt and beer. For this reason it has two market classes--feed and malting. Acceptable malting varieties are those which have been approved by the malting and brewing industry. Approval is given after a barley selection has been tested in plant-scale tests of 10,000- or 20,000-bushel lots from at least 3 different crop years. The grain of a selection must have such physical characters (plump, sound, and bright) and chemical characters (low protein, high enzymatic activity, high extract) as are required to permit the economical production of malt. Grain of varieties which do not have the required chemical characters or grain of any variety which is unfit because of growing conditions or improper handling is classed as feed barley (Price).

The process of developing a new barley variety follows the same general pattern outlined for wheat. Some of the objectives are different because of the utilization of

the crop. Historically the same varieties were used for feed and malting--an unsatisfactory situation. Varieties of both classes should have high yield and bushel weight, heat- and drought-tolerance, good standability and resistance to most common barley diseases (Price).

The divergence between the two classes comes in the chemical grain characters. Quality parameters have been rather well established by the malting industry during the past 50 years. Objectives of malting barley are to meet the increasingly stringent industry requirements. This has not been the case with feed barley. Research is aimed at making rather major genetic changes (1) higher oil content to provide more energy, and (2) proteins with a higher biological value and better amino acid balance, so feed barley can achieve a more competitive stance against other feed grains (Price).

Feebar, released in 1947, and Liberty, released in 1957, were developed as feed barley varieties. The name "Feebar" is a contraction of the words "feed barley." Liberty received its name because its breeding number was SD 1776.

OTHER GRAIN VARIETIES DEVELOPED IN SOUTH DAKOTA

By 1980 eleven varieties of oats, eight of barley and one of rye had been developed.

<u>Variety</u>	<u>Crop</u>	<u>Year of Release</u>	<u>Variety</u>	<u>Crop</u>	<u>Year of Release</u>
Cole	oats	1909	James	hulless oats	1950
Ace	barley	1919	Waubay	oatsey	1954
Fowlds	hulless oats	1925	Dupree	oats	1954
Dryland	barley	1925	Liberty	barley	1957
Hope	HRS wheat	1925	Ortley	oats	1963
Nakota	hulless oats	1939	Primus	barley	1967
Miomark	oats	1941	Kota	oats	1969
Vikota	oats	1943	Primus II	barley	1969
Feebar	barley	1947	Chief	oats	1972
Plains	barley	1948	Prilar	barley	1972
Pierre	rye	1950			

STATE PRODUCTION

The development of higher yielding oats varieties and better production techniques brought about higher average yields. The state average yields were 21 bushels per acre in 1900, and 10-year average yields were 25 in the 1920s, 30.1 in the 1940s, 38.7 in the 1960s and 46.5 bushels per acre in 1978.

Though barley acreage was lower, the 680,000 acres planted in 1977 produced more

grain than was produced on 900,000 to 1.2 million acres prior to 1926. The development of higher yielding varieties and improved production methods resulted in gradually increasing yields. The average state yields were 10 bushels per acre in 1900, and 10-year average yields were 22 in the 1920s, 24.5 in the 1940s, 34.3 in 1960s and 37 bushels per acre in 1978.

State average yields of rye fluctuated between 11 and 18 bushels per acre for 60 years. However, between 1958 and 1975, they were

generally between 23 and 34 bushels. South Dakota generally produced more rye than any other state.

The acreage of emmer declined considerably. Only an occasional sample was submitted to

the Seed Laboratory from 1939 to 1943, when this writer assisted with seed testing. During the 1960s and early 1970s there was usually one sample of emmer among the 400 to 500 samples entered in the State Crop Shows that this writer supervised.



Oats that has been harvested with a binder and put in shocks to dry for threshing in 1927.



Small grain committee 1967-1970: (standing) E.P. Adams, Ext. soil fert.; P. B. Price, barley breeding; R. C. Ward, soil testing; L.A. Derscheid, co-chairman; J. Sanderson, farm management; (sitting) R. Albrechtsen, oats breeding; F. C. Westin, co-chairman; D.G. Wells, wheat breeding. (Photo 1969).

CHAPTER XIX SORGHUM

It is believed that grain sorghum originated in Africa. It was introduced into Egypt in prehistoric times and moved to India and then to China where it was known as late as the fourth century of the Christian Era. Kaoliang was known as the great millet of the Chinese. Sweet sorghum also originated in Africa, but probably followed a different route (Bul 285).

Most sorghums are classed as grass sorghum, forage sorghum, grain sorghum or broom corn.

The two major grass sorghums are sudangrass and the perennial weed, Johnsongrass, that is a weed in southern states.

Forage sorghums included sorgo which is sometimes called saccharine or sweet sorghum because it produces sweet juice. The juice of some sorgos is used for making sorghum syrup. Sorgo also includes black and red amber cane that produce rank growth and relatively small amounts of black or red seed. Forage sorghum hybrids are developed by crossing several types of sorghum.

Grain sorghum includes kafir, white and yellow milo, feterita, durra, kaoliang and hegari. Grain sorghum hybrids are derived by crossing grain sorghum with sudangrass.

Grain sorghums were planted in various parts of the United States but could not compete with corn in areas favorable to that crop. With the settlement of the high plains of Western Kansas, Eastern Colorado and the Panhandle region of Texas and Oklahoma, milo and kafir became dependable crops. They withstood drought and excessive heat better than corn and made comparable yields under more favorable growing conditions (Bul 135).



C. J. Franzke in sorghum crossing block.

EXPERIMENT STATION PERSONNEL

Several of the staff members listed in the

first section of Chapter III and the superintendents of substations raised sorghum. However, only a relatively few put major emphasis on the crop. They were C. J. Franzke from about 1930 until his retirement in 1964, his assistant Mary E. Sanders from 1956 to 1960, and his successor Allyn O. Lunden from 1964 to 1976. James G. Ross and over a dozen of his graduate students conducted numerous cytological and cytogenetic studies on sorghum treated with colchicine during the 1950s and 1960s.

Graduate Students

Dale D. Harpstead	M.S.	1952-1953
A. Earl Foster	M.S.	12/1/54-1956
Glenn F. Atkinson	M.S.	1955-1956
A. Earl Foster	Ph.D.	1956-1959
Hubert D. Haensel	M.S.	1957-1961
Chester C. Huang	M.S.	1959-1961

Jan-Ru P. Chen	M.S.	10/1/59-9/30/63
Alvin W. Ericksen	Ph.D.	4/1959-9/31/63
Gerald S. Simantel	Ph.D.	7/1960-5/1/63
Chen Ho Chen	Ph.D.	6/1/60-9/30/63
John R. Deakin	Ph.D.	1962-1965
Peck-Sun Lin	Ph.D.	1964-1967

In February 1964 C. J. Franzke spoke at the annual meeting of the South Dakota Crop Improvement Association in Gregory on the subject "Sorghum History and Development in South Dakota." It was perhaps his last contribution to the state as he retired later that year. Many excerpts from that talk are included here.

SORGHUM IN SOUTH DAKOTA

Sorghum culture in South Dakota is about as old as the state. Kafir corn, Jerusalem corn, brown doura and yellow milo maize, which was classified as a saccharine (sweet) sorghum, were planted for forage production at Brookings in 1893 (Bul 51). Some sorghums were planted on the Hunter Farm, near Mellette in 1897 (Bul 59) and sorghums were included as fodder crops in the first plantings made on the Highmore Substation in 1899 (Bul 66).

Principle reasons for testing and growing sorghum was its adaptability to hot weather and limited rainfall too dry for corn. Sorghums were able to remain dormant during periods of drought and begin growth with the advent of light showers while corn, under the same conditions, withered and dried up. It was recommended from early tests that sorghums be grown in Central and Western South Dakota to stabilize feed production. Sorghums would be the main row crop in the cropping system to serve as an important supplement to corn

rather than a substitute due to prospective drought and grasshopper infestations (Franzke).

It was thought that sorghums would be grown in the central and western portions of South Dakota because of their drought-resistance. The development of early varieties was expected to increase their more general culture (Bul 101).



B. L. Brage and shock of black amber sorghum.

Though several types of sorghum had been grown at Brookings, the Hunter Farm and the Highmore Substation, it was not an important crop in 1912. By that time it was determined that amber cane was best suited for forage, and that milo, kafir, kaoliang and a kafir-durra cross were best suited for grain production. Head selections had been made each year in an attempt to develop improved strains (Bul 135).

Kaoliang and black amber sorghum were included in the long-time rotations established at the Highmore, Cottonwood and Eureka Substations in 1912 and at Brookings in 1914. Kaoliang was also planted at the Vivian Substation in 1914 (Bul 162). In these experiments sorghum was compared with corn as a row crop that would serve as an element in a mixed farming operation. Yields for both grain and forage were obtained.

Forage sorghums were preferred to grain sorghums. The early grain sorghums (kafir corn, Jerusalem corn, and yellow milo maize) ripened unevenly; the milos had curved head stalks or "goose-neck", that interfered with harvesting; they were too tall for the ease of handling and too late maturing to produce high quality grain. Also, seed sown more than one inch deep failed to germinate or penetrate to the surface. Seed planted in cold wet soils rotted. Seedlings made feeble growth during the first month of planting. Weak spindling growth was only 2 inches tall while corn, at the same time and under the same conditions, made a strong vigorous growth of 6 inches (Franzke).

Since kafir and milo had proven themselves in the Southern Great Plains, it was desirable

to learn if there were varieties that would mature early enough for the Northern Great Plains. The USDA obtained seed of hardy sorghums grown in China and Manchuria. In China they were known as kaoliang meaning "tall millet". The USDA unsuccessfully attempted to adopt the spelling of "kowliang". It was used for the production of food, grain and forage. It had the desirable characteristics of drought tolerance and early maturity (Bul 135).

Kaoliang was introduced by the USDA to fill the demand for an early ripening grain sorghum. The fodder was not as good feed as corn because of fewer leaves and hard, woody stems. It was recommended as a good row crop in the cropping system and as a seedbed preparation for winter wheat (Franzke).

Kaoliang was tested as a possible food. On January 9, 1915, kaoliang pancakes and kaoliang bread were served to over 100 farmers who attended the Farm and Home conference at SDSC. Members of the Home Economics Department developed and published recipes for using kaoliang flour to make bread, pudding, mush, pancakes, ginger bread, doughnuts, cookies, buttermilk waffles and muffins (Bul 158).

Interest in sorghum grew. In 1917 it was said that sorghum was a profitable crop to grow when weather conditions were unfavorable for corn. Varieties of amber cane were the best forage producers, while sudangrass made good hay and outproduced millet (Bul 174).

However, sorghum acreage abated after World War I, perhaps because the price of wheat was so high. Research results indicated that sorghum could displace corn as a cultivated crop in rotations, but in a far greater area it would be a supplement to corn. Yields of grain from corn had been higher than those from sorghum at Brookings, Highmore, Eureka and Cottonwood, however, the difference was small at the latter location (Bul 185).

The South Dakota planting of sorghum in 1932 was about 69,000 acres, of which 54,000 were sudan. In 1933 the estimate had increased to 166,000 acres. The rise in acreage may have been due to unfavorable cropping conditions such as grasshoppers and drought (Bul 185).

Acreage increased significantly during the drought years of 1932 to 1939. Sorghums were used to supplement the drought-stricken pastures. However, during the early 1930s many livestock were lost from prussic acid or nitrate poisoning obtained from drought-stricken sorghums. Perhaps this is why acreage dropped even in 1936, the second of the two driest years. However, nearly 1.5 million acres were

planted each year from 1939 through 1941, with less than 20% harvested for grain.

C. J. Franzke developed two low acid amber cane varieties. Only these two varieties, of the more than 200 available, could be grazed during the 1976 drought without fear of prussic acid poisoning.

Though grain sorghum yields rivaled the yields of corn in some areas, corn was preferred for several reasons. It was easier to harvest, dry and feed, especially to hogs. The development of the open-panicled cultivars that produced heads well above the flag leaf facilitated both the harvesting and drying operations.

Early maturing sorghums brought about more general culture in central and western areas of the state because of their drought endurance and grasshopper resistance. In these areas sorghum in the cropping system was an important supplemental row crop to corn rather than a substitute. For years sorghums had produced forage for ruminants, and now they were excellent feed for all classes of livestock. They were used as grain, pasture, hay, fodder, silage, and for industrial uses. With the release in 1964 of the variety Winner, sorghum could even be used as an emergency crop (Franzke).

The advent of grain sorghum hybrids in the mid-1950s increased yield potential and the number of acres harvested for grain in South Dakota doubled. Since then about half of the 400 to 500 thousand acres of sorghum were harvested for grain (Lunden).

Large quantities of the grain were used in breweries and distilleries for making alcohol and other products. The large, white-seeded types were milled into flour that was used for making quick breads, yeast breads, griddle cakes, and many other pastries. The waxy endosperm types were a substitute for taro in manufacturing minute tapioca. Many types of mucilages, made from sorghum grain, were used largely in manufacturing gypsum board, sheet rock, and other products. There were starches, dextrose, dextrose syrup, edible oils, industrial waxes, and many other products. In industrial uses, sorghum grain was next to corn (Franzke).

Though the most productive acres were reserved for corn, and grain sorghums were planted on less productive land, yields of grain sorghum increased from a 10-year average of 12 bushels per acre during the 1940s, to a 10-year average of 36 in the 1960s, to a high of 50 bushels in 1977 and 1978 (Lunden).

SORGHUM BREEDING

Techniques for breeding sorghum were similar to those used for small grain, flax and millet until the mid-1950s when C. J. Franzke started to develop hybrids.

Mass Selection

In 1912 several suggestions were made for securing seed. Since most sorghums were cut for forage before the seed ripened, it was suggested that a few rows be allowed to mature. The best heads should be selected. Some were poorly filled and light while others were compact and heavy. The heavier heads on sturdy leafy plants should be selected, tied up in bunches and hung to dry. (Bul 135).

Pedigree Breeding

In 1905 W.A. Wheeler and Sylvester Balz collected seed of 40 of the earliest plants of three amber canes grown at Highmore. One of the varieties was called Early Minnesota Amber. Seeds from these selections were grown in pedigree or centgener rows (100 plants per row) in 1906 (Bul 101). Further records from the work are not readily available. Perhaps the program was discontinued because Dakota Amber, a selection from Minnesota Amber, was developed shortly afterwards at the Belle Fourche Field Station by D.C. Dillman. It was released in 1913 (AES 14) and was an important variety in 1916 (Bul 174).

In 1909 Manley Champlin planted three varieties of brown kaoliang, one of black kaoliang, two of milo and two selections from a cross between kafir and durra at Highmore. Head selections were made each year for the most promising strains (Bul 153). Altamont, a selection from brown kaoliang, was available as a variety in 1920. It may have been selected at Cottonwood (Bul 185).

C. J. Franzke initiated an extensive sorghum breeding program at Brookings in 1930. This planting consisted of 30 varieties of grain sorghum, 12 varieties of forage sorghums and six strains of sudangrass (Franzke).

During the drought of the mid-30s sorghums played an important role in producing feed for livestock. Farmers planted Dakota Amber Cane, Altamont kaoliang, feterita, Cheyenne kafir, Early Kalo, kalo, Sooner milo and Colby milo.

Farmers and livestock producers became quite concerned with the production and feeding of sorghums due to enormous losses of livestock from hydrocyanic acid (prussic acid) poisoning.

In 1932 research began on this problem. It was learned that factors controlling hydrocy-

nic acid in sorghum were heritable and could be modified by selection and breeding. The diurnal variation of hydrocyanic acid in sorghum plants had three maximum and three minimum periods during a 24-hour period. Sorghum varieties and strains varied in their diurnal acid content trends and had different maximum and minimum periods. Also, the amount of hydrocyanic acid in sorghum was affected by weather conditions, stage of growth, variety or strain and the storage of fodder (Franzke).

There were two main types of durrins, the nitrile-glucosides producing hydrocyanic acid in plants. One type was only liberated by hydrochloric acid as in some species of acacia and only poisoned animals having mastication digestion. The other was liberated by enzymatic reaction. It was found in sorghums, sudangrass and Johnsongrass; only ruminant animals were poisoned. Sorghum put up for silage was a safe feed as fermentation inactivated the enzyme (Franzke).

There were apparently three kinds of nitrile-glucosides in sorghum. In one type, green plants were poisonous, but 90 to 95% of the acid in harvested forage was liberated in 6 weeks while the fodder was curing. In a second type, about 5% of the poison was liberated from fodder during the curing process. If wet fodder froze and the frozen forage was fed to livestock, it became toxic when released after thawing in the animals digestive tract. In the third type, some sorghum strains liberated free HCN gas during their growth and were not injurious to livestock because the acid content in the plant was never high (Franzke).

In 1936 at the Highmore Substation, three types of sorghum were planted for pasturing. One type released its acid while curing as fodder, another retained its acid content when curing and the third released the gas while growing. When the acid content was at its maximum level, they were pastured with an old discarded dairy cow. The animal was taken off feed 24 hours before being turned on the sorghum plots, then it was rotated from one plot to the next. Every time it grazed sorghum that released its acid in cured fodder, it suffered from acute forage poisoning. There were no ill effects from the other two. Forage was harvested from the sorghum that retained the acid in the fodder and cured for 10 days. It was dampened with water, frozen and fed to the cow in the frozen state. Soon the cow developed acute forage poisoning (Franzke).

Franzke and L. F. Puhr had performed several thousand analyses to produce those sorghum strains. However, a selection from Dakota Amber that had been grown at Cottonwood since

1913 was released as the variety 39-30-S in 1937. It was the first low acid variety released in the world (Franzke).

Cross-breeding

This technique was similar to cross-breeding described for small grains. The anthers on the heads of one variety were removed. Pollen from the heads of another variety was dusted on the exposed pistils of the emasculated heads and the entire head was covered with a sack to prevent contamination from other pollen sources.

Rancher, a variety that only contained 10% as much hydrocyanic acid as 39-30-S, was the first sorghum variety developed in South Dakota by crossing two varieties. Franzke crossed 39-30-S with 19-30-S, a high acid selection from Dakota Amber, and backcrossed to 39-30-S. It was released in 1945 (Cir 57).

After the release of 39-30-S and Rancher, there were no reported losses of livestock from pasturing sorghum or from feeding the fodder. Dr. Robertson at Colorado State College stated in the late 1940s that these two low acid sorghums saved millions of dollars worth of livestock in Colorado (Franzke).

Up to this point emphasis had been placed on developing sorghums that did not produce much seed but retained feed value in leaves and stems. Increased seed production meant more glumes and dark colored glumes contained tannic acid which lowered milk production when fed to dairy cows. However, research conducted in Arkansas had shown that the crude protein in sorghum was the highest in the leaves and grain head and the lowest in the leaf sheath and stem. It seemed that it would be much more economical to produce a high quality forage with less tonnage per acre than one with a high yield and low quality (Franzke).

Emphasis was switched from forage sorghums to grain sorghums which produced more grain and straw colored glumes with lower tannic acid content. Objectives of the grain sorghum breeding program were to develop new varieties that had large seeds and sturdier, larger seedlings that did not go dormant when 2 to 3 weeks of age; to develop early maturing disease- and insect-resistant varieties with semi-open to open heads, that extended 6 to 9 inches above the flag leaf; varieties that produced high yields of good quality grain and had stronger stalks so they would stand longer after being frosted (Franzke).

Norghum sorghum was developed by cross breeding and released in 1949. It was the first early maturing grain sorghum to be

released. U. J. Norgaard was responsible for the name meaning North Sorghum. Mrs. Franzke claimed this variety because her maiden name was Norman. This variety pushed the grain sorghum belt more than 500 miles north (Franzke).

Norghum had an open seed panicle which allowed air movement to dry the seed quicker in the field; but like other varieties, it lodged soon after it was frosted.

Reliance, a grain variety released in 1953, was derived from the cross of Modoc x Sooner milo made in 1939. Modoc was a white-seeded, late maturing variety having the seed head well above the flag leaf. The purpose of the cross was to develop a variety of Sooner milo which would have good yield, earlier maturity, stand longer after a killing frost and bear the seed panicle well above the flag leaf (Bul 426). These characteristics and the open panicle made it the first sorghum variety that was adapted to being harvested by straight combining. Reliance was the parent of A and B male sterile lines that were used as parents of several hybrids.

Hybridization

During the late 1950s Franzke started to develop sorghum inbreds. Panicles were covered with sacks so that only the pollen from a specific plant would fertilize the stigmas of the same plant. After six or seven generations, the inbreds were relatively homozygous. Single-cross hybrids were produced by using pollen from one inbred to fertilize the heads of another inbred. Since the male and female organs in sorghum were in the same flower, a system of detasseling as done with corn could not be used.



Sorghum crossing block.

Dr. J. C. Stephens of Chillicothe, Texas, was said to be the father of hybrid sorghum. He discovered cytoplasmic sterility and he worked out the mass seed production method for male sterile lines. The female organs in the flower were normal, but the male organs did not produce viable pollen. There were two

types of male sterility--heritable and cytoplasmic. Heritable male sterility was not used by sorghum breeders because 30 to 60% of the plants produced pollen. In a large field it was impossible to rogue out all of these pollen shedders. Some plants would be self pollinated, causing contamination of the hybrid (Franzke).

Franzke inbred Reliance and added a male sterility gene to create Reliance ms. It was male sterile and did not produce pollen. Several rows of it were planted alternately with two rows of SD 102 which provided the pollen to fertilize the male-sterile flowers of Reliance ms. Seed from the male sterile or female parent was planted to produce SD 441, the first hybrid grain sorghum developed in South Dakota.

In 1960 Sokota produced the first South Dakota sorghum hybrids for commercial use. The Foundation Seed Stocks Division in 1959 increased SD 102, the A and B lines of SD Reliance ms and the A and B lines of SD Martin #1 ms. Sokota Hybrid Seed Producers put in a sorghum processing plant and started their own production of South Dakota sorghum. The cooperative produced, processed and marketed SD 441 and SD 451 and one year later did the same with SD 252F (Franzke).

Colchicine, a Breeders Tool

An alkaloid, extracted from the wild crocus bulb, had been used for over 100 years in the medical profession for treating such problems as kidney ailments, gout and arthritis. In 1932 it was discovered that colchicine doubled chromosome numbers in plants. During the winter of 1947-48, Franzke developed a method of using this drug to treat young germinated sorghum seedlings in the greenhouse.

Beginning in 1952 the drug was used as a breeders tool for inducing new germplasm in sorghum, safflower, sunflower, soybeans, castorbeans, and crambe. Also some work was done with flax, corn, grasses and legumes. Colchicine induced true-breeding diploid mutants immediately and saved the sorghum breeder several years of work. He could produce (1) true-breeding lines from pure lines, (2) true-breeding lines immediately from crossed progenies eliminating 6 to 8 years of inbreeding and (3) secure male sterile A and B lines within 3 years without backcrossing 6 to 8 years (Franzke).

Franzke used colchicine to develop male sterile Martin and the varieties Dual, Winner and SD 100. He used Martin ms as the female parent for hybrids SD 451, SD 502, and SD 252F; SD 100 as the male parent for hybrids SD 502 and SD 503. Dual was the male parent

for SD 252F. After 1964 A.O. Lunden used lines developed with the use of colchicine by Franzke to develop hybrids SD 104, SD 106 and RS 506, and he used Martin ms to develop SD 106 ms (Lunden).

Dual was released in 1958 as the first dual-purpose sorghum. It had large seed, large seedlings, open heads, was very leafy and had sweet juicy stalks. Winner was released in 1964 as an emergency crop--the first sorghum

released for that purpose. It was an early-maturing, dwarf grain sorghum which could be used either as a grain crop or as fodder. It was short, leafy, had sweet juicy stems, produced 4 to 5 tillers per plant and the seeds ripened on the tillers at the same time as on the main stalk. It produced best when planted from early mid-June to the early part of July in rows spaced 6 to 12 inches apart. It was expected that this variety would push sorghum production 300 to 400 miles farther north.

SORGHUM VARIETIES AND HYBRIDS DEVELOPED IN SOUTH DAKOTA

<u>Cultivar</u>	<u>Type</u>	<u>Pedigree</u>	<u>Year Released</u>
Dakota Amber	Forage	Sel. of Minn. Amber	1913
Altamont	Grain	Sel. of Brown kaoliang	Pre 1920
39-30-S	Forage (low HCN)	Sel. of Dakota Amber	1937
Rancher	Forage (low HCN)	(39-30-S x 19-30-5) x 39-30-S	1945
Norghum	Grain variety	(Dwarf feterita x Dwarf freed) x yellow kafir	1949
Reliance	Grain variety	Modoc x Sooner milo	1953
Dual	Dual purpose	Colchicine + complex crosses	1958
Reliance ms	Grain variety	Reliance(6) x Martin ms	1959
SD 102	Grain hybrid	Colchicine + complex crosses	1959
SD 441	Grain hybrid	Reliance ms x SD 102	1959
SD 451	Grain hybrid	Martin ms No. 1 x SD 102	1959
SD 100	Grain variety	Colchicine + complex crosses	1961
SD 502	Grain hybrid	Martin ms No. 1 x SD 100	1961
SD 503	Grain hybrid	CK-60 ms x SD 100	1961
SD 252F	Forage hybrid	Martin ms No. 1 x Dual	1961
Winner	Grain variety	Colchicine + complex crosses	1964
SD 104	Grain hybrid	Colchicine + complex crosses	1971
RS 506	Grain hybrid	CK-60 ms x SD 104	1971
SD 106	Grain hybrid	Colchicine + complex crosses	1973
SD 106 ms	Grain	SD 106(4) x Martin ms	1974



C.J.Franzke discussed sorghum breeding--Agronomy Field Day 1950s.

CHAPTER XX OIL CROPS

Flax was planted in the first crop rotation experiment at Brookings in 1897. Three varieties of sunflowers were planted in 1897 on the Hunter Farm. Soybeans were used as a legume crop raised for hay or pasture from time to time and were tested for both hay and seed production at Brookings in 1919.

FLAX

Flaxseed was often the money crop of the pioneer. When sod was plowed for the first time, flax was generally the first crop raised on it. Breaking sod required more horsepower than plowing of cultivated land. Four horses were required for a one-bottom breaking plow, but two could pull a walking plow on previously cropped land. Consequently, the breaking frequently was not completed until late in the spring. Flax was better adopted to late planting than grain was. Also, it was a poor weed fighter and generally produced better on the weed-free seedbeds provided by newly broken sod.

Flax was a good cash crop and a good companion crop for legume seedings. Acreage gradually increased to over a half million acres in 1910, but declined for almost a decade. Much of the state was settled and the breaking of sod was completed; acreages of corn, oats and alfalfa increased.

However, the paint industry started to use large amounts of linseed oil and there was a demand for flax. Flax used for linseed oil averaged 26.7 million bushels from 1911 to 1920, but increased to 30.5 million in 1921, 38.2 million in 1922, 37.5 million in 1923 and 40 million in 1924 (Bul 213). The acreage increased until it reached 830,000 acres in 1930. At that time flax was grown in every county in the state. The heaviest concentration of acreage was in Codington and Deuel counties, but it was a common crop in the northern one or two tiers of counties as well as Bennett and Washabaugh in the southwest. Common flax was planted on many acres. It did not withstand the drought of the 1930s and acreage declined.

John Schoof developed the flax variety Bush. He was from Hume's hometown in Indiana and urged Hume to come to South Dakota. He homesteaded in Spink County, but later moved to Gettysburg where he developed the variety.

Varieties Bison, Linota and Redwing started a resurgence in flax production. The momentum was maintained by Dakota and Crystal and accelerated by Marine, Redwood and B-5128. Each new group of varieties possessed more disease

resistance and higher yield potential. As a result, acreage increased to an all-time high of one million acres in 1954. During the 1960s acreage remained between 500 and 600 thousand acres. South Dakota and Minnesota alternated between second and third highest flax producing states behind North Dakota. Summit, the first South Dakota variety, was released in 1964.

Acreage started to decline in 1971, and price rose to \$11.00 a bushel in 1972. This brought the price of linseed oil to over \$35. Paint companies accelerated their use of water-soluble paints and others found substitutes for linseed oil. For the remainder of the 1970s flax prices were not exceptionally good but it appeared that there was sufficient demand to make it profitable to raise around 300,000 acres in the state.

State acreage yields for flax increased from 6 bushels per acre in 1900 to 10-year averages of 7.9 in the 1920s, 10 in the 1940s, 12.2 in 1960s and 12.5 in 1978.

PERSONNEL

Staff Members

D. D. Harpstead	1953-1961
R. Albrechtsen	1962-1969
D. L. Reeves	1970-1974
C. L. Lay	1975-

Graduate Students

Mick Mwala	1978-1980
Peter S. Chmay	1977-
Nancy K. Black	1977-1978

Flax Varieties Developed in South Dakota

<u>Variety</u>	<u>Year of Release</u>
Summit	1964
Culbert 79	1979

SOYBEANS

Soybeans are native to Eastern Asia and were grown in China and Japan for hundreds of years, primarily for food consumption. They were introduced into the United States shortly after 1800 but did not become popular until the end of the century. At that time importations were made into Kansas (Bul 193).

During the early 1900s they were used primarily as a green manure crop, but also as hay and pasture. Though they were better adapted to southern climates, they could be grown

almost as far north as corn (Bul 193). Soybeans were planted when stands of clovers failed in the long-term experiments established at Brookings and the substations.

Soybeans were becoming increasingly popular in South Dakota, and in 1919 a dozen varieties were tested for both forage and seed production (Bul 193).

Though an extensive soybean breeding program has not been conducted by the South Dakota Agricultural Experiment Station, variety testing was conducted for over a third of a century. In 1936 South Dakota started to cooperate in the Northern Regional Uniform Soybean Test Program conducted by the twelve North Central States and two provinces of Canada (Lunden).

Numerous varieties were evaluated by C. J. Franzke until 1964 and then by A. O. Lunden, for their adaptation to South Dakota. They and others studied the effects of various planting rates, row widths and other cultural practices on yield and the use of herbicides for weed control.

Manchukota, released through the Foundation Seed Stock Division in 1946, was the first of 20 early to medium maturing soybean varieties released jointly by two or more states for use by South Dakota soybean producers (Lunden).

Through the use of adapted varieties and good production practices, soybean acreage increased from 2,000 acres in 1939 to 102,000 in 1960 and 400,000 in 1978, while yields rose from 12 bushels per acre in 1940 to 17 in 1960 and 30.5 in 1978, with a high of 48 in 1972.

SUNFLOWERS

Native sunflowers were being used as food by the Indians in Virginia in 1586, and improved varieties were developed in Europe before 1600. Sunflower oil was being used in New England as a hair dressing in 1615 (Bul 621).

Domestic sunflower culture was established in the United States following the introduction of improved varieties from Europe shortly after 1880. Three varieties of sunflowers were planted on the Hunter Farm near Mellette in 1897.

One year later E. C. Chilcott wrote, "The seeds of sunflowers are used in many ways. They are fed directly to stock and poultry. They are crushed and the oil used for domestic purposes such as illumination. They are used as a substitute for sweet oil. The residue is fed to livestock like cotton seed meal. The stalks are used for fuel. In some parts of

Russia the peasants eat the whole seed (Russian peanuts) just like our people consume peanuts" (Bul 59).

Sunflowers were grown in a sunflower-barley-legume rotation at the Cottonwood Substation for 13 years from 1920 to 1932. Sunflowers produced no more than 700 pounds field dry weight of forage in any year and graded downward in several seasons to 53 pounds. Forage yields at the same location ranged from 1 to 2 tons per acre for sorghums and legumes. Sunflowers failed to produce any seed during 7 years, and yields ranged from 14.8 to 61.4 pounds per acre during the other 6 years (Bul 312).

During the early 1900s sunflowers were grown primarily as a silage crop in the Northern Great Plains and the Prairie Provinces of Canada (Bul 621).

During 1921 L. W. Wilson and A. H. Kuhlman fed silage made from corn, sunflowers and mixtures of both to beef steers. Average daily gains over a 60-day period were 1.26 pounds for corn silage, 1.16 for three-fourths corn and one-fourth sunflower, 0.78 pounds for a 50-50 mixture and 0.17 for three-fourths sunflower. They lost 2.83 pounds per day when fed 100% sunflower silage (Bul 199).

Production of sunflowers as an oilseed crop began in Canada in 1943 and Minnesota in 1947. However, Minnesotans started raising the crop for birdfeed in 1952 and about 70% of the sunflower crop was raised for that purpose for about a decade (Bul 621).

The 1966 importation of varieties from Russia that contained 40 to 50% oil in their small, black, thin-hulled seeds increased interest in the production of sunflower oil in Minnesota (Bul 621).

Fear of infection by the sunflower moth in South Dakota and southern Minnesota limited the sunflower growing area to the Red River Valley and adjacent counties in North Dakota and northern Minnesota for several years (Bul 621).

Variety performance tests were conducted from 1968 to 1971 by Harry A. Geise on the Agronomy Farm and the South Central Research Farm near Presho, and by Quentin S. Kingsley on the Whetstone Valley Research Farm near Twin Brooks and Milbank, and the West Prairie Coteau Research Farm near Garden City (Bul 621).

The Russian varieties Peredovik, Vinimk, and Krasnodarets were the leading oil producing varieties, but the experimental hybrid P 21 x HA 60 outyielded them. Arrowhead was

the best yielding low oil variety but, because of its small seed, it was used only for bird-feed. The large-seeded Mingrin and Commander were raised for human food. Large seeds were roasted whole and sold as "Russian peanuts" and medium large seeds were dehulled and used for the nutmeat trade. Small seeds were used as birdfeed (Bul 621).

Though these varieties were open pollinated, they were mostly "incompatible" and relied largely on insects to carry pollen from one plant to another to give maximum seed production.

About 100 acres of sunflowers were produced in South Dakota in 1969. At that time all sunflowers were raised under contract to Honeyamead Products or The Cargill Co. of Minneapolis.

P 21 ms x HA 60 was an experimental hybrid developed by the USDA in Texas during the late 1960s. It was followed by the hybrid 896. Though both had greater yield potential than the Russian varieties, both were susceptible to rust. The USDA released the hybrid 894 in 1972 or 1973, and Cargill 204 was released a year later--both were rust-resistant.

More importantly, they produced much higher yields than the Russian varieties and were largely self compatible. They were self pollinated and did not require insects to carry pollen from one plant to another in order to produce high seed yields. Needless to say, they stimulated interest in sunflower production.

In 1973 the Crop and Reporting Service compared the estimated gross income from sunflowers with those of spring grains, flax, corn and soybeans (Bul 621). With market prices of that date, sunflowers was a more profitable crop than oats or barley and about equal to flax in areas where it was not necessary to use expensive insecticides.

W. E. Arnold evaluated numerous herbicides for use in controlling weeds in sunflowers. Tests were conducted at the Northeast Research Farm near Watertown and the James Valley Research and Extension Center near Redfield. Several herbicides proved to be effective. Entomologists also developed insecticides that would control most of the sunflower insects. However, two to three sprayings were required to control sunflower moth.

In the spring of 1974 the Dean of Agriculture called a meeting of several research and extension specialists in crops, soils, weed control, entomology, pathology, and economics to discuss sunflower production. Extension specialists decided to assemble all the available information into Bulletin 621 "Sunflowers in South Dakota" and researchers discussed

ways of "bootlegging" funds from other projects to conduct experiments with sunflowers.

From 1974 to 1978 the Extension Agronomist and farm management specialists from the Economics Department calculated the production costs of eight major crops in each of six areas of the state. Sunflowers was one of the crops considered for north central counties. The cost per acre for sunflowers was higher than for any other crop except corn. However, when the cost per unit of production (cwt, bu. or T) was compared with the anticipated market price, sunflowers appeared to be a more profitable crop than alfalfa, corn or small grains in 1977 through 1979.

A few commercial seed companies began selling sunflower seed in 1975 and several more started in 1976. USDA 894 was sold under several trade names. As U.S. acreage increased from 787,000 acres in 1974 to 1.28 million in 1975, 1.1 in 1976, 2.3 in 1977 and 2.8 million in 1978, a decreasing percentage of the acreage was raised under contract. Most of the seed was marketed through Honeyamead Products and The Cargill Co., and these companies were able to process the seed and provide considerable storage. Demand grew faster than production and there was never a surplus.

Reestablishment of acreage controls by federal farm programs on wheat and feed grains in 1978 and 1979 and a decreasing demand for flax left the door open for sunflowers in 1979.

Accurate figures for sunflower acreage in South Dakota were not obtained until 1979. However, it was estimated that acreages for 1975 through 1978 were 50,000, 100,000, 136,000 and 165,000 acres. In 1979 acreage increased about 50% nationwide, but it mushroomed to 612,000 acres in South Dakota. While most of the acreage was in the northeastern quarter of the state, at least one field was planted in every East River county and all of the counties north of U.S. Highway 14 in West River.

Processing plants could not store the seed. Many producers did not make advanced arrangements for storage or marketing and numerous growers were 300 to 400 miles from a market. Yield was not as good as expected, especially for first-time growers and in southern and western counties. Because of marketing problems and lower than desired yields in some areas, the South Dakota acreage dropped to 450,000 acres in 1980.

However, the Minneapolis and Duluth Grain Exchanges added sunflowers to their lists of commodities and Futures Markets were established as for many other crops. Sunflowers became a major crop, not only in the U.S., but in South Dakota.

CHAPTER XXI VARIETY PERFORMANCE TESTING

Variety testing was one of the main functions of the Agricultural Experiment Station in 1888 when Luther Foster tested for yields 32 varieties of corn, 20 of wheat, 23 of oats, 12 of barley, 20 of grass and 28 of minor crops. Under agreements with the USDA, variety performance testing on small grains was initiated in 1901 and 1906 on alfalfa.

Small grain variety comparison studies have been conducted almost continuously since that date, while alfalfa testing was conducted intermittently for about 20 years, essentially discontinued for a quarter century and resumed on a limited scale in the 1950s.

Testing of corn varieties was conducted now and then for 15 or 20 years beginning in 1904, however, with the influx of hybrid corn, testing became a continuous program beginning in the late 1930s. Testing of grain sorghum hybrids became an important program in the 1960s.

For many years variety testing programs were conducted by plant breeders, however, in 1962 this important service was consolidated into one program so crop breeders would be freed of this routine function. A large number of varieties were tested each year for yield and for visible evidence of disease susceptibility. The results were a ready source of information for comparing the productivity of different varieties and were used extensively by South Dakota farmers and ranchers.

Small Grains and Flax

In the spring of 1901 the South Dakota Agricultural Experiment Station entered into an agreement with the Bureau of Plant Industry of the U.S. Department of Agriculture to cooperate with small grain investigations. Under the agreement the work was to be carried on at Brookings and one other location farther west in the state. The Experiment Station agreed to furnish land, teams, machinery and labor, and the USDA was to furnish seed and pay part of the expenses (Bul 96).

E. C. Chilcott was in charge of the work and was commissioned collaborator by the U.S. Secretary of Agriculture. John S. Cole, a senior student at the College, was appointed Special Agent in the cooperative work at Brookings. Sylvester Balz was a Special Agent at the Hunter-Salzer farm near Mellette (Bul 96).

In 1903 it was decided that there was more land at the Highmore Substation than was needed to carry on tests of forage crops. The

small grain variety testing was transferred from Mellette. Balz moved to Highmore where he continued as Special Agent with the USDA and became Superintendent of the Highmore Substation.

Chilcott resigned June 30, 1905, to take a position with the USDA. Cole continued the work at Brookings until 1908. The tests at Highmore were handled by Balz until 1906, by Cole in 1907 and 1908 and by Manley Champlin from 1909 to 1911.

The 1903 tests at Highmore included 47 varieties of macaroni (durum) wheat, 26 of barley, six of oats and two each of bread wheat and emmer. Six strains of Kubanka durum from Central Asia, Swedish Select oats from Sweden, Sixty day oats from Russia and Chevalier, Hanna and Manchuria barley were among the varieties grown (Bul 84).

Wild Goose was the best and five Kubanka strains in the top ten durums at Highmore in 1905, while two strains of Chevalier and six of Hanna led the list of 31 barley varieties, which also included Primus and Hannchen. Red Fife and Blue Stem were the best of ten hard red spring wheat varieties and Swedish Select and Sixty Day were the best of eight oat varieties (Bul 101).

Velvet Chaff was the top yielder of 12 wheat varieties at Highmore in 1907, and six new Minnesota selections were top wheat producers in 1908. Khersion joined the leaders on a list of 24 oat varieties (Bul 115).

At Brookings six barley varieties were compared in 1902 and 1903. The number was increased to 24 in 1904, 36 in 1905 and 37, including three hullless varieties, from 1906 to 1908. Kitzig, Swan Neck and Chevalier were the highest yielding of twenty 2-row varieties with 4- and 5-year average yields of 45.1, 43.5 and 41.2 bushels per acre. Odessa and Minnesota 6 led the nine 6-row varieties with 5-year average yields of 43.9 and 40.5 (Bul 113).

During the tenure of Clifford Willis, as Chief in Agronomy, performance testing was de-emphasized, but superintendents at substations continued tests on a limited basis. In 1912 A. N. Hume asked Champlin to take charge of cereal investigations at the substations. He supervised variety performance testing from 1912 to 1920. He was succeeded by Edwin W. Hardies who served from 1924 to 1928 as supervisor of substations. Variety testing at Brookings was conducted by Clyde M. Woodworth in 1911 and 1912, I. S. Oakland in 1913 and

1914 and Mathew Foulds from 1915 to 1928. Variety comparison trials at Newell were conducted by Cecil Salmon and John Martin during the period 1909 to 1919.

Since periodic reports were written for individual crops, the same system is followed here.

Flax 1911-1915

Flax varieties were compared at Highmore from 1911 to 1915 and on both dryland and irrigated land at Newell from 1912 to 1915. Drought caused a complete crop failure at Highmore in 1911 and near failure in 1912. Yields were 7 to 9 bushels per acre in 1914 and 24 to 32 bushels in 1915. Yields on dryland at Newell were 8 to 11 bushels in 1912 and 17 to 23 bushels per acre in 1915. Owing to poor soil on which irrigated flax was grown, the yield was about the same as on dryland. The results indicated that a North Dakota selection was somewhat superior to the other nine varieties (Bul 169).

Barley 1909-1916

In 1909 and 1910, 16 varieties were planted at Eureka and 8 to 10 varieties at Highmore and Cottonwood. The number was reduced to about four at Eureka and Cottonwood, 8 to 10 at Highmore and 10 to 15 at Brookings from 1912 to 1917 (Bul 183).

Odessa was the leading variety at three locations. Manchuria was tops at Eureka and second at Brookings. It was recommended for areas where lodging was apt to be a problem. Hannchen produced well at the three substations and White Smyrna did well at Eureka and Cottonwood. Hulless varieties did not compare favorably with other varieties. Oderbrucker was tested at Cottonwood and Eureka in 1909 and 1910, at Highmore from 1910 to 1912 and Brookings from 1913 to 1917. Average yields for Odessa were 52 bushels per acre at Brookings, 34 at Highmore and 19 at Cottonwood. Manchuria produced 27 bushels at Eureka (Bul 183).

Barley 1917-1930

Each year during this period variety performance tests included 10 to 30 varieties at Brookings and five to 25 at Highmore. Ace, a selection from White Smyrna made at Highmore in 1915, was first included in tests at Brookings in 1922 and at Highmore in 1924. Velvet first appeared in 1926, Trebi in 1927 and Glabron in 1928. Spartan and Barbless (Wis 38) were not in performance tests, but were in the breeding nurseries in 1929 (Bul 256).

Over the 14-year period Odessa, Oderbrucker and Manchuria had the highest average yield at Brookings, but the newer varieties, Horn and Trebi, looked promising. At Highmore, Odessa had the best 14-year average but several newer varieties, including Oderbrucker and Coast, had a better 7-year average. Ace, Glabron, Horn and several crosses between Coast and Lyon produced better 3-year average yields. Average yields for the highest yielding varieties were 47 bushels per acre for Odessa at Brookings, and 29.6 and 26.7 for Coast and Odessa, respectively, at Highmore (Bul 256).

Winter Wheat 1913-1922

Though four varieties of winter wheat were grown at Highmore each year from 1913 to 1922, and two grown at Brookings each year from 1916 to 1922, variety performance tests were not initiated until 1918 at Highmore and 1919 at Brookings. They included several strains from each of Kharhof, Turkey, and Kanred. In 1922 it appeared that Kanred would be the best variety (Bul 200).

Variety performance tests were initiated at Eureka in 1925. By 1932 it appeared that Minturki, Kharkof and Turkey 144 were the best varieties. Kanred gave good yields but was less winterhardy (Bul 276).

Spring Wheat 1913-1922

Variety performance tests annually included 7 to 10 wheat varieties at Brookings, Highmore and Eureka, while two or three varieties were grown each year at Cottonwood. Acme, a selection from Kubanka made at Highmore in 1910 and designated as a variety in 1914, was first included in performance tests at Highmore in 1914, Brookings in 1916 and Cottonwood and Eureka in 1918. Marquis was a new variety in 1913. Velvet Chaff was renamed Preston. Kota, which appeared to be more tolerant to stem rust than Marquis, was included in 1920. The best yielding durum varieties consistently outyielded the hard red spring varieties. Kubanka, the most popular durum, outyielded Marquis, the most popular hard red spring variety, 17.4 to 13.9 bushels per acre at Brookings, 17.4 to 13.5 at Highmore, 15.8 to 11.7 at Cottonwood and 15.6 to 14.8 at Eureka. Acme performed well at some locations with average yields of 19.2 bushels per acre at Eureka, 16.8 at Cottonwood and 17.7 at Highmore, but it had low milling quality. Kota was not a high yielding variety (Bul 201).

Spring Wheat 1925-1931

Ceres was added to the list of hard red spring varieties in 1925. Reward was added in 1926, Hope in 1928 and Reliance in 1929. The best yielding bread varieties at Brookings

were Ceres, Reliance, Quality and Reward, with average yields of about 20 bushels per acre. Ceres and Reward were the best at both Highmore and Eureka with average yields of 13 to 14 and 15 to 16 bushels, respectively. Mindum, which was added to the list of durums in 1925, was the outstanding durum at Brookings with an average yield of 27.6 bushels per acre. Acme was tops at Highmore and Nodak at Eureka with yields of 19 bushels, followed closely by Kubanka and Mindum. Acme was not recommended, however, because of low quality (Bul 268).

Oats 1916-1927

Several oat varieties were grown each year at Brookings and Highmore. Early varieties included Sixty Day, Cole, Richland, Albion and Gopher, which was added in 1925. Midseason varieties were Swedish Select and Silvermine. Hulless varieties tested only at Brookings were White Russian, added in 1922, and Fowlds Hulless, added in 1923 (Bul 230).

At both locations, the early maturing varieties were the best yielders. The four best varieties averaged 17 bushels per acre more at Brookings and 11 more at Highmore than the best two midseason varieties. Richland topped the list at Brookings with an average yield of 71.2 bushels per acre. Gopher, however, produced a 3-year average of about 70 bushels at Brookings. Cole was a selection from Sixty Day made at Highmore. Fowlds Hulless was developed at Brookings (Bul 230).

Revised System

K. H. W. Klages took charge of varietal experiments during the summer of 1928. For the next 30 years the small grain breeders conducted the variety performance tests and reported all crops in one publication at 1- to 2-year intervals.

Klages conducted the experimentation from 1928 to 1935. Other breeders were S. P. Swenson from 1936 to 1941, J. E. Grafius from 1942 to 1952, E. R. Hehn in 1942 and 1943, V. A.

Dirks from 1947 to 1961 and D. D. Harpstead from 1953 to 1961.

Klages used triplicate 1/60-acre plots (probably 5.5 feet x 8 rods), with cropped alleys for spring-sown crops. It is assumed that the plots were harvested with a binder, shocked and threshed in a threshing machine. Winter wheat, however, was seeded in rod-row plots.



Variety Performance tests in 1937.

Either Swenson or Grafius started using triplicate rod-row plots for all grains. Planting and harvesting, as described earlier, was performed by plant breeding personnel, but hoeing to control weeds was done by substation employees. Harvested bundles were transported to Brookings for threshing.

Small Grains 1928-1934

Ten or a dozen varieties each of oats, barley and hard red spring wheat and three of durum were tested for 5 years at Brookings and Highmore, 3 years at Eureka and one year at Cottonwood. A dozen winter wheat varieties were compared for 4 years at Brookings and 3 years at Highmore. Five flax varieties were tested 4 years at Brookings, Highmore and Eureka and one year at Cottonwood (Bul 291).

Based on the results from these tests, variety recommendations made in 1934 were as follows:

<u>Crop</u>	<u>Variety</u>	<u>Area</u>
HRS Wheat	Ceres Marquis Reward	Entire state North Central & Western North Central
Durum	Mindium Kubanka	Entire State Central & Western
HRW	Minturki Turkey Beloglina	Southern & East Central Southern & East Central Southern & East Central

Oats (early)	Richland & Iogold Albion & Gopher Cole	Entire State Eastern & Central Central
Oats (medium)	Rainbow Swedish Select Silvermine	Eastern & Northern Northern Eastern
Barley	Odessa Velvet Wisconsin 38 Glabron Trebi, Horn, Ace White Smyrna	Entire state Eastern one-third Southeastern Eastern & Central Central & Western Western
Flax	Bison Redwing Linota	Eastern & Northern Entire state Central & Western
Rye	Swedish Advance Dakold	All rye growing areas All rye growing areas

Farmer Cooperators

In 1929 K. H. W. Klages and Ralph Johnston, the Extension Agronomist, planted spring wheat demonstration plots on three Brown County farms. Yield samples were harvested and the bushels per acre calculated (Bul 268).



Variety Performance Test and Demonstration on J. J. Wallace Farm near Britton in 1930.

In 1930 barley variety plots were planted on the farms of F. J. McHugh of Ordway, J. J. Wallace of Britton and T. C. Wenz of Bath. Each demonstration included three to five varieties (Bul 256). Also demonstration plots, containing three to six spring wheat varieties, were planted on 15 farms in Northeastern South Dakota (Bul 268).

This was the start of two programs. The Extension Service and County Crop Improvement Association have continued to use variety demonstration plots on farmer's fields as a basis for discussing small grain varieties. Also, Standard Variety Trials have been con-

ducted on cooperators farms for more than a decade in areas not represented by substations.

Small Grains 1935-1957

Variety tests were conducted on the Agronomy Farm and the three substations at Highmore, Eureka and Cottonwood. Many new varieties were added (Bul 452; Cir 86, 103, 113 & 136).

Barley varieties included Spartan in 1937; advance lines of Feebar and Plains in 1942; Velvon 11, Tregal, Kindred and Mars by 1947; Moore and Montacalm in 1950; Custer in 1953 and Traill, Fox, Parkland and Liberty in 1955.

Oats varieties included Bunker, Trojan, Vikota and Tama by 1942; Mindo Clinton and Bonda by 1946; Andrew, Osage, Cherokee, Nemaha, Marion, James Hullless, Shelby, Zepher and Ajax by 1948; Dupree in 1950; Branch in 1951; Waubay, Clintafe and Clarion in 1952; Sauk and Clintland in 1953; Garry, Rodney and Trojan in 1955 and Burnett in 1956.

New bread wheat varieties Rushmore, Thatcher, Mida, Ceres, Rival, Pilot and Cadet and new durums Venum and Stewart were added in or before 1942. Lee, Redman and Selkirk were added in 1948, 1949 and 1953; and Spinkota and Eller in 1955. Nugget durum was added in 1950 and Yuma, Ramsey, Langdon and Towner in 1955.

Kota, Dakota and Crystal flax were added in or before 1942; Sheyenne, Marine, Arrow, Redwood, Royal, B-5128 and Minerva in or before 1948; Rocket in 1951; Victoria Selection in 1952 and Norland and Raja in 1955.

New winter wheats included Nebred and Minter, added in 1946; Pawnee, Marmin and Iowin

in 1947; Iohardi in 1949; Sioux and Wichita in 1955 and Yogo, Cheyenne, Concho and Triumph in 1956.

Pierre, Dakold and Emerald winter rye were added in 1946; Tetra Pektus was added in 1953 and Antelope, Caribou, Adams and Horton in 1955.

In 1951 Tregal and Velvon were considered to be the outstanding feed barley varieties, however Plains was more drought tolerant. Wis 38 and Montcalm were the best malting varieties. Feebar, Tregal and Velvon 11 were criticized for being hard to thresh and Kindred for shattering too easily. Odessa was criticized for lodging, and Plains criticized for being damaged by a late spring freeze (Bul 422).

Rushmore, developed by J. E. Grafius, was the outstanding hard red spring wheat variety, but Mida performed well in the central area of the state. Stewart was the best durum. Lee and Thatcher were early varieties that escaped the drought as did the early durum, Venum. The 1950 appearance of Race 15B of stem rust caused serious damage to the durums, but Lee and the durums were more tolerant to leaf rust (Bul 422).

Marine, Redwood, B-5128 and Crystal were superior to older flax varieties with the earlier variety, Marine, being suggested for drier areas (Bul 422).

Minter winter wheat was extremely winter hardy, and more tolerant of stem rust than Nebred. Pawnee was not hardy enough for South Dakota. Pierre outyielded other rye varieties except Emereld when it did not winter kill (Bul 422).

In 1954 and 1955 Velvon II and Tregal continued to be desirable barley varieties. Richland and Vikota were top yielding oat varieties at Brookings and Eureka. Andrew and Dupree also did well at Brookings, while James, Osage and Ajax were good producers at Eureka. Lee and Rushmore were the recommended bread wheats, but the 1952 epidemic with Race 15B of stem rust had made it unwise to raise durum. Marine and Sheyenne were the recommended flax varieties for north central counties, but Redwood was recommended for the Brookings area. Minter and Nebred were the best winter wheats for the Brookings area and Pierre was the recommended rye variety (Cir 103 & 113).

CORN

Though corn was planted annually at Brookings and Highmore, tests to give critical comparisons of varieties were not conducted.

Corn 1903-1923

W. A. Wheeler observed eight varieties on 1/10- to 1 1/2-acre plots at Highmore in 1903, but only one dent variety and squaw corn matured. He also observed eight sorghums in 1/10- to 1/5-acre plots (Bul 84).

Wheeler and S. Balz planted eleven corn varieties in duplicate plots at Highmore in 1904 and 1905. None of them matured the first year, but because of a favorable fall and late frost, all but one matured in 1905. Minnesota 13 gave the largest yield and produced the best quality corn. It was mature by September 15 and yielded 45.5 bushels per acre (Bul 96).

In 1906 Wheeler and Balz compared eight varieties of dent corn and five of flint. Of the dent varieties tried, only Minnesota 13, an early white dent from North Dakota, and an early yellow dent from Brown County seemed worthy of extended trials. The flint varieties produced good yields, but the ears were too close to the ground (Bul 101).

Corn variety comparisons for both grain and stover production, conducted by Manley Champ- lin, involved a dozen varieties at Brookings from 1914 to 1916 and Highmore from 1912 to 1916 and a half dozen varieties at Cottonwood and Eureka from 1913 to 1916 (Bul 181).

For grain production, the flint varieties consistently out produced the dent varieties. Yields were 90 bushels per acre for squaw corn at Brookings, 28 for Disco and White Flint at Highmore and 50 for Purple Flour at Eureka. Minnesota 13 was the best dent corn at Brookings and Highmore with yields of 62 and 21 bushels per acre. Northwestern Dent was best at Eureka--the yield of 34.3 bushels was three times as high as any other dent. Silver King and Dakota White did well at Brookings while Ardmore, Martins White Dent and Silver King were tops at Highmore. Corn matured only 2 years out of 5 at Cottonwood (Bul 181).

The flints also produced more forage. Over 20 tons of silage per acre were produced by Squaw corn and Rainbow Flint at Brookings and Purple Flour corn and Rainbow Flint at Eureka, while Disco Flint produced over 9 tons at Highmore. Northwestern Dent and Minnesota 13 were tops at Cottonwood with 3 tons. Minnesota 13 was also the top silage producing dent at Highmore, with almost 9 tons. It was second to Northwestern Dent with 10.7 tons at Eureka and near the bottom of the list at Brookings. Dakota Yellow Dent, with a yield of 17.6 tons per acre, was the best silage producing dent corn at Brookings (Bul 181).

In 1923 SD 86, a selection from Minnesota 13 made at Brookings, was recommended for a

large area in the northern half of the state. Though Northwestern Dent was a high yielder at Highmore and Eureka, it did not have uniform color.

Alta, a selection from SD 86 made at Highmore, was recommended as a yellow variety and Silver King, formerly Wis 7, as a white variety for the Highmore area. Alta and Eureka 13, a selection from Minn 13 made at Eureka, were recommended for the Eureka area (Bul 204).

Wimple's Yellow Dent, developed by A. J. Wimple of Beresford, was a somewhat larger variety and recommended for southern areas of the state. Fulton Yellow Dent, selected at Fulton by H. E. Dawes, was adapted to central counties as far north as Spink. Reid's Yellow Dent was later maturing than other varieties and best adapted to Southeast South Dakota (Bul 204).

Corn 1939-1960

Replacement of open-pollinated varieties by hybrids had not been as rapid in South Dakota as in states farther east. Apparently, the reluctance was primarily due to the difficulty of ascertaining the hybrids that would produce the largest average yield under the extremely variable climatic conditions prevalent in the corn growing area of the state (Cir 45).

Yield tests were conducted to supply information to corn growers that would enable them to choose high yielding cultivars adapted to their area and also to provide seed producers with the data necessary for developing better combinations. Tests were conducted at five locations in 1938, seven in 1939, and nine in 1941 and 1942. Only one to four varieties were planted in 1938 or 1939, but 10 to 15 were planted in 1941 and 1942 (Cir 45).

In 1942 Erhardt R. Hehn, a 1940 graduate who wished to take graduate work, was hired to handle small grain and corn performance testing. He, under the supervision of John E. Grafius, conducted the 1942 and 1943 tests but was taken into the army before the 1944 planting season. Grafius planted the 1944 tests which were harvested by the newly employed Karl E. Manke.

For the next 15 years, corn tests were conducted by the corn breeder and his assistants. Manke planted the 1945 and 1946 tests, however, he left before harvest time. Two students, Donald E. Kratochvil and Keith Wilcox, did the harvesting. D. Boyd Shank, corn breeder, conducted the tests from 1947 to 1957. He was assisted by Glen E. Nachtigal, now manager of Sokota Hybrid Producers, in 1951 and 1952, and D. E. Kratochvil, now corn breeder for Sokota, from 1953 to 1957.

As early as 1942 the region of the state with an average annual rainfall of 21 inches or more was divided into nine districts. This included the area east of Aberdeen, Redfield, Huron, Wessington Springs, White Lake, and Geddes. With the aid of county agents, sites were located on nine farms that represented the general conditions of the nine districts. The test plots were located in the cooperator's fields of corn. Each cooperator prepared the seedbed and did the cultivating in the same manner as the rest of the field. Each entry was planted in a plot consisting of two rows with 10 hills each and replicated six times. Tests were hand planted at a rate of three kernels per hill, except that two kernels were planted in the two western districts (Cir 45).

In early September notes were taken on stand, smut, ear droppage, ear and stalk height and lodging. Harvesting was done by hand.

In 1943 twelve open-pollinated varieties were used as check varieties. They were Alta, Brookings 86, Brown County Yellow Dent, Early Murdock, Eureka Yellow Dent, Fulton Yellow Dent (Swope), Fulton Yellow Dent (Vincent), Golden Jewel, Minn. 13, Reid's Yellow Dent, Silver King and Wimple's Yellow Dent. Two or three of these varieties were included at each location (Cir 50). It is interesting to note that most of these varieties were discussed 20 years earlier. In all probability, SD 86 and Brookings 86 were the same. Eureka Yellow Dent may have been the same as Eureka 13 or it may have been a selection from Northwestern Yellow Dent.

Seventeen hybrid seed producers were listed as having contributed seed in 1943. One was Sokota Hybrid Growers, but none of their hybrids were listed. Top producers that had been tested 3 to 5 years in the nine districts were Funks G-212, Master F 106, Turner S 52, Silver King, Pioneer 353 A, Kingscrot D-4, Iowearth 5, Funks G-1 and Pioneer 355 (Cir 50).

Several firsts took place in 1945. The nine districts were modified to include the entire state in ten districts. The use of open-pollinated varieties, as check varieties, was discontinued. A survey was conducted among seed producers and distributors and the State Department of Agriculture to determine which hybrids were important. Tests for District 7 were conducted on the Agronomy Farm. Seven hybrids that had been developed by the Agronomy Department and produced by Sokota were included in the tests. Sokota 224, 220 and 230 were the best yielders at Highmore, an area for which they had been developed. They and Sokota 204, 212 and 420

were in the low moisture group in most tests (Cir 60).

The ten districts were reduced to eight in 1946 (Cir 66) and these were slightly modified in 1947 (Cir 71). When D. B. Shank took charge of the testing, he began putting tests on the substations at Highmore and Eureka. He also gave each entry a performance score which was determined by using moisture percentage as well as yield to rank hybrids by their ability to produce mature corn (Cir 71).

Starting in 1949, tests for District 2 were conducted on the Range Field Station at Cottonwood. Of the 20 to 24 hybrids in each test, those with the best performance scores in the eight districts were DeKalb 46, Hansmann, SD Exp 9, Funks G-1A, Tomahawk 30 and Sokota 400. SD Exp 9 had the best score in Brown and Brookings counties and ranked second in Lawrence, fourth in Hanson and fifth in Minnehaha counties (Cir 79).

Tests were conducted on dryland and irrigation at the Redfield Development Farm starting in 1951 (Cir 93) and on the Newell Field Station in 1954 (Cir 112). They were conducted for the first time on the newly established Northeast Research Farm near Watertown and the Southeast Research Farm near Menno in 1956 (Cir 139).

Performance trials were discontinued in 1957. Hybrids with the best 5-year average performance scores in the 14 tests were SD 250 (2), Funks G-18, SD 420, SD 270, Pioneer 338 (2), SD 400, Kingscrot K54, Disco 101-A, DeKalb 410 (2), United Hagie 32A and Pioneer 349 (Cir 139). SD 210, SD 220, SD 262, SD 604, SD 622, and SD Exp's 17 and 18 were also included in the tests. All SD numbers had been developed by corn breeders in Agronomy Department.

FORAGES

Forage testing was the primary purpose for establishing the Highmore Substation. Numerous grasses were compared with one another at that location and at others, but variety comparisons were not made for nearly a half a century. Alfalfa varieties were compared somewhat more frequently.

Variety testing of alfalfas in cooperation with the USDA was initiated at the Highmore Substation by W. A. Wheeler and S. Balz in 1906. About 20 regional varieties were seeded in duplicate square-rod plots (Bul 101). Turkestan, Baltic, Grimm, Oasis, Tripoli and Arabian were among the varieties compared. Turkestan, Baltic and Grimm produced satisfactory yields over a 6-year period. Arabian was less productive and Oasis and Tripoli were not

winter hardy. Similar tests were initiated on West Farm at Brookings, perhaps by N. E. Hansen or C. Willis, in 1908 (Bul 133).

Vale, Grimm and Turkestan were planted at the Cottonwood and Eureka Substations by Manley Chamlin in 1912. Though the results from the various locations differed somewhat, it was stated in 1916 that "Alfalfa varieties may be recommended in the following order: Vale, Grimm and Turkestan (Bul 163).

Several variety comparison studies were conducted on the USDA station at Redfield. Varieties planted in 1916 included Baltic, Grimm, Turkestan, Dakota Common and Kansas Common. Ladak and Cossack were included in the 1921 seedings. Ladak was the most outstanding variety for hay production. It produced an exceptionally large first crop, but it recovered slowly after cutting. Cossack and Grimm were also superior to the other varieties. Though several other varieties were planted in 1929 and 1930, the same three varieties were the best producers. Ladak outyielded Cossack by 16.7%, Grimm by 22.0% and others by 40 to 60%. Baltic and Turkestan were winter hardy. Baltic produced almost as much forage as Grimm, but Turkestan was a poor yielder (Bul 383).

Ranger was added to the list of varieties tested by E. L. Erickson at Brookings in 1942. Atlantic and Buffalo were added in 1947, and Narragansett and Williamsburg were added in 1949 by M. W. Adams. In 1950 it was stated that Cossack and Ladak had the growth characteristics suited to survival in the Northern Great Plains, and Grimm and Ranger were also adapted (Cir 81).

Grass

James G. Ross planted four varieties of smooth brome grass and one variety each of intermediate, crested, western and slender wheatgrass, Russian wildrye, Kentucky bluegrass and red fescue at Highmore (Cir 124). Similar plantings were made on the Redfield Development Farm in 1949 and 1950 (Cir 107). In 1956 he planted 13 varieties of smooth brome grass, 10 of intermediate wheatgrass and 8 of crested wheatgrass at Brookings (Bul 502).

In 1961 the variety suggestions included Homesteader, Lancaster and Lincoln brome grass, Fairway and Nordan crested wheatgrass and Nebraska 50 and Ree intermediate wheatgrass (Bul 502).

SORGHUM

Sorghum yield trials were initiated at Eureka in 1949 by C. J. Franzke. The test

included Norghum, Reliance, Martin, Midland, Sooner Milo, Early Kalo and Improved Coes. Norghum and Reliance, two varieties developed by the Agronomy Department, were recommended in 1954. Most of the other varieties matured too late for the Eureka area (Cir 103).

SOYBEANS

Variety comparisons were initiated by C. J. Franzke at Brookings in 1949. The first test included Chippewa, Blackhawk, Earlyana, Monroe and Ottawa Madarin. Ottawa Mandarin had been the reliable variety, but by 1955, it appeared Blackhawk had a somewhat higher yield potential, and Chippewa, a new variety, looked very promising (Cir 113).

TESTING FOR A FEE

J. J. Bonnemann and G. W. Erion

In 1962 Dean O. G. Bentley wrote: "The Variety Test Program is a new service function initiated during the biennium. Its purpose is to carry variety tests on a fee basis to determine the adaptability of varieties of commercial crops offered for sale in South Dakota where such information is desired. An attempt is being made to run the program on a cooperative basis with the seedsman and seed-producing companies to the mutual benefit of the trade and the farmers" (K-137).



J. J. Bonnemann

The Crop Performance Testing program became an entity in the spring of 1961 when the variety testing of proprietary corn hybrids was placed under the supervision of one project leader as a function of the Statewide Testing Program of the Agricultural Experiment Station. Robert Carlson, a graduate student of Fred Shubeck, and Durwood W. Beatty, assistant corn breeder, conducted the first corn trials under the new program.

All seed companies that developed corn or grain sorghum hybrids or alfalfa varieties were told that a fee would be charged for performance testing their materials. Six corn companies had entries in the 1961 tests located at the Agronomy Farm, the Southeast Experiment Farm near Beresford, the Northeast Research Farm and the Redfield Development Farm. Grain sorghum tests were conducted at Brookings and Beresford.

Joseph J. Bonnemann became project leader on September 1, 1961. As an undergraduate he had worked with Grafius and Dirks on the Small Grain Standard Variety Trials and he conducted these tests at the Newell Field Station from 1951 to 1961 when he was a staff member at that location. He worked closely with D. B. Shank, Beatty and C. J. Franzke that first fall, learning the harvest methods they employed for corn and grain sorghums.

The program was expanded in 1962 to include small grains and alfalfa. Fees were not charged for small grain because seed companies had not started to develop varieties. The trials had previously been conducted by the small grain breeders. Though Bonnemann was somewhat familiar with procedures used for small grain, he consulted with the small grain technicians. Breeders, Dirks and Harpstead had departed and their replacements, Albrechtson and Wells, did not arrive until after the small grain crops were seeded in 1962. The spring grains and flax varieties were tested at the stations located near Brookings, Highmore, Eureka, Newell, Beresford and Watertown. Winter wheat and rye varieties were tested at the stations located near Brookings, Highmore and Presho.



J. J. Bonnemann in rod row-performance tests.

Companies that developed alfalfa varieties declined to enter the program. However, with the assistance of alfalfa breeder, M. D. Rumbaugh, a few proprietary alfalfa varieties were seeded at Highmore in 1962 to determine

winterhardiness and whether they would meet ASCS requirements for winterhardiness for cost-share payments.

During that same year, eleven companies had corn hybrids in the seven tests at the North Central Substation near Eureka, the Redfield Development Farm, and two private farms, as well as the three locations used in 1961. Grain sorghum hybrids were compared at Brookings, Watertown, Beresford, Eureka, Highmore and Presho. One year later ten companies submitted sorghum hybrids that were tested at Cottonwood, Newell and the Norman Lein farm near Platte, in addition to the six locations used in 1962.

Though alfalfa companies declined to pay a fee for the tests, they were willing to provide seeds and variety descriptions. Since there was a need for some kind of evaluation of the dozens of proprietary varieties, tests were established at Brookings in cooperation with Rumbaugh. Seedings made on the Agronomy Farm in 1972, 1973 and 1974 included about 40 varieties.



Alfalfa variety performance tests.

Prior to 1976, soybean variety tests were conducted by the soybean and sorghum project. They were initiated by C. J. Franzke and continued by his successor Allyn O. Lunden from 1964 to 1975. However, the project closed and some personnel were transferred to the Crop Performance Testing program. Performance testing of soybean varieties and regional

tests of both sorghum and soybean varieties were added to the program on July 1, 1976.

Personnel

As the workload increased a full-time technician, Robert L. Morris, was employed from 1964 to 1977. He was replaced by Kevin K. Kirby June 1978. When the sorghum-soybean breeding program was terminated in 1976, G. W. (Bill) Erion and technician Lucian E. Edler became part of the Performance Testing Program.

Students were employed on an hourly basis as full-time help in the summer months and as needed or available during the school year. As personnel were out in the state for several days at a time during seeding and harvest, it was difficult to hire student help and take them away from the campus.

Much of the work involved close cooperation with the breeders of the various crops. Help was frequently exchanged to avoid making several trips to one site when one crew could accomplish the work. Thus, extra travel and lodging expenses were eliminated.

Test Locations

Trials were conducted on research farms operated by the Experiment Station, USDA or Bureau of Reclamation, as well as with many farmer-cooperators. Though long-term averages were easier to obtain by working at government-operated substations, these did not always have the most representative soil types for a particular crop. When that was the case or if a substation had been phased out, it was necessary to locate trials with farmers. Farmer locations at Wall-Quinn, Geddes and Bison became long-term testing sites.

Number of Plots

The number of locations for each crop multiplied by the number of varieties at each location gave the number of plots in each replication. They were tabulated for the years 1962 to 1979. These numbers multiplied by the number of replications (usually four) give the actual number of plots for each year.

Yearly tabulation of the Entries x Locations for the years 1962 to 1979 inclusive.

Year	Grain							Spring	
	Corn	Sorghum	Alfalfa	Oats	Barley	Flax	Rye	Wheat	Winter Wheat
1962	90	25	7	35	12	12	--	20	--
1963	119	41	8	32	15	15	--	20	15
1964	142	47	10	30	15	20	4	15	16
1965	136	59	15	27	15	15	5	15	15
1966	145	53	10	33	16	13	5	18	16
1967	137	56	13	32	14	15	24	18	16

1968	160	46	--	30	12	12	20	21	16
1969	132	49	--	30	8	13	16	17	16
1970	158	50	--	27	8	20	14	21	16
1971	159	56	--	24	11	13	12	25	20
1972	215	61	36	26	13	20	8	30	18
1973	240	63	36	30	12	--	8	28	30
1974	208	52	20	30	12	--	12	41	30
1975	209	41		24	17	--	13	36	32
1976	182	62		26	14	--	4	38	30
1977	179	62		30	14	--	4	40	37
1978	184	62		31	20	--	--	25	28
1979	190	70		27	19	--	--	25	30

Trials conducted by the Crop Performance Testing Program from 1962 to 1980.

<u>Location</u>	<u>Crop</u>	<u>Years</u>	<u>Comments</u>
Agronomy Farm	Spring wheat	1962 to 1980	
	Oats	1962 to 1980	
	Barley	1962 to 1980	
	Winter wheat	1973 to 1980	
	Rye	1962 to 1977	
	Corn	1961 to 1980	
	Grain sorghum	1961 to 1980	
	Flax	1962 to 1974	
	Alfalfa	1972 to 1979	
	Soybeans	1976 to 1980	
Central Substation	Spring wheat	1962 to 1980	
	Oats	1962 to 1980	
	Barley	1962 to 1980	
	Winter wheat	1962 to 1980	
	Rye	1962 to 1977	
	Alfalfa	1962 to 1970	
	Grain sorghum	1962 to 1975	
Harrold*	Grain Sorghum	1976 to 1979a	Moved here from Highmore, fewer birds. Discontinued for lack of interest in 1980.
North Central Substation	Corn	1962 to 1971	
	Spring wheat	1962 to 1971	
	Oats	1962 to 1971	
	Barley	1962 to 1971	
	Grain sorghum	1962 to 1968	
Selby*	Spring wheat	1972 to 1980b	Moved from Eureka when station closed.
	Oats	1972 to 1980b	
	Barley	1972 to 1980b	
Gettysburg*	Corn	1972 to 1973b	Moved here when Eureka closed
Agar*	Corn	1974 to 1977	Moved from Potter Co.
Onida*	Corn	1978	Moved southwest 10 miles from Agar abandoned in 1979 for lack of interest
Range & Field Station	Spring wheat	1962 to 1964	
	Oats	1962 to 1964	
	Barley	1962 to 1964	
	Winter wheat	1962 to 1964	
Wall-Quinn ^{5/}	Spring wheat	1965 to 1980c	Trials at Cottonwood 1909-1964 moved when agronomic research
	Oats	1965 to 1980c	

	Barley	1965 to 1980c	discontinued to area more representative of crop growing area of the region. Local demand.
	Winter wheat	1967 to date	
Newell Field Station	Spring wheat	1962 to 1965	
	Oats	1962 to 1965	
	Barley	1962 to 1965	
Bison*	Spring wheat	1966 to 1980d	
	Oats	1966 to 1980d	
	Barley	1966 to 1980d	
	Winter wheat	1970 to date	
Irrigation Development Farm	Corn-dryland	1961 to 1980	
	-irrigated	1967 to 1980	
	Grain sorghum		
	-irrigated	1964 to 1980	
	Winter wheat	1973 to 1980	
	Rye	1973 to 1977	
	Soybeans	1976 to date	
SE Experiment Farm	Oats	1962 to 1980	
	Corn	1961 to 1980	
	Grain sorghum	1961 to 1980	
	Barley	'62-68; '74-80	
	Spring wheat	'62-68; '74-80	
	Winter wheat	1962 to 1968	
	Rye	1962 to 1968	
	Soybeans	1976 to 1980	
NE Research Farm	Spring wheat	1962 to 1980	
	Oats	1962 to 1980	
	Barley	1962 to 1980	
	Flax	1962 to 1973	
	Corn	1961 to 1972b	
	Winter wheat	1967 to 1972b	
	Rye	1967 to 1972b	
	Grain Sorghum	1962 to 1972g	
Letcher*	Grain sorghum	1974 to 1980h	
Gary	Corn	1974 to 1980i	
SC Research Farm	Grain sorghum	1962 to 1973	
	Winter wheat	1962 to 1973	
Presho*	Winter wheat	1975 to 1980g	
Kennebec*	Grain sorghum	1974 to 1980g	
Geddes*	Corn	1967 to 1980	In Platte area from '62'66 but planter didn't work in lister furrows
	Grain sorghum	1967 to 1980	
Dimock*	Corn	1962 to 1963	Cooperator died
Parkston*	Corn	1964 to 1969	Moved from Dimock
Bridgewater*	Corn	1970 to 1979	Moved from Parkston, dropped in 1980
Bath-Groton*	Spring wheat	1975 to 1980	Initiated at request of breeders for site in this part of state
	Oats	1975 to 1980	
	Barley	1975 to 1980	Supervised by Lay
	Flax	1975 to 1978	
Revillo*	Soybeans	1976 to 1979	
Wilmot*	Soybeans	1980	

* Post Office address for farmer cooperator.

a Moved to private farm from Central Substation.

b Moved to private farm when the North Central Substation closed.

c " " " " Cottonwood Range Field Station closed.

d Moved from Newell Field Station to more representative area.

e On Whetstone Valley satellite 1969-1972.

f On West Prairie Coteau satellite 1970-1972.

g Moved to private farm when South Central Research Farm closed.

h " " " " West Prairie Coteau satellite closed.

i " " " " Whetstone Valley satellite closed.

VALUE OF PERFORMANCE TESTING

Performance data were published intermittently until 1961. However, annual reports were issued for corn and small grains starting in 1962 and for grain sorghum starting in 1963. Soybean reports were circulated every 1 or 2 years after 1964 and alfalfa results were distributed every 3 to 5 years.

Corn and sorghum reports were circulated to hybrid producers, crop improvement members and other growers for use in evaluating hybrids for their own purposes.

The project was not directly responsible for the release of any cultivars, but the data gathered were very useful. They helped crop breeders and the cultivar release committee decide whether to either increase and release or discard experimental lines of most crops tested.

Results from small grain, forage crops and soybeans tests were used in making recommenda-

tions to growers. Each November performance testing personnel, crop breeders and Extension crops specialists reviewed the results. Since all varieties being increased for release and all recently released varieties were compared with varieties that had proven to be adapted to various areas of the state, the group of agronomists was able to collectively decide which small grain, flax, soybean and forage crop varieties to recommend to growers in the 13 crop adaptation areas of the state.

Extension Agronomists, in cooperation with county Extension agents and County Crop Improvement Associations, had small grain and flax variety demonstration plots at 40 to 50 locations in the state. The demonstrations contained newly released varieties, those being increased for release and several proven varieties of each crop. Farmers were able to see these varieties grown under their environmental conditions and hear Extension Agronomists evaluate them. They were able to determine whether they wanted to secure seed of new varieties, sometimes before the seed became available.



Bundles from harvested rod-row plots in Seedhouse ready to thresh.

CHAPTER XXII CROP MANAGEMENT

The first spring after the Experiment Station was established spring grains were planted in two different ways and at several rates and dates of planting on the newly acquired West Farm at Brookings. Within the decade a crop rotation experiment was established. Later different methods of planting were compared.

DATES AND RATES OF PLANTING

Experiments to determine the best time to plant and the optimum rate of seeding were conducted from time to time for all the major crops.

Small Grains and Flax

As early as 1888 Luther Foster, superintendent of agricultural experiments, planted oats, barley and spring wheat at several seeding rates on more than one date. Though the crop was ruined by drought and rust, the number of straws per square foot of area was counted. As seeding rate increased from 4 to 8 pecks, in 1-peck increments, the number of straws gradually increased from 41 to 54 (Bul 11). The experiment was repeated the next year with spring wheat. The best yield was obtained from seeding rates of 4 1/2 to 5 pecks per acre (Bul 17).

Tests conducted from 1914 to 1916 by Manley Champlin showed that the best seeding rate for barley was 6 pecks per acre at Brookings, 6 to 7 pecks at Highmore, and 5 to 6 pecks at Eureka. Highest yields were obtained when the crop was planted between April 20 and 25 at Brookings and before April 20 at Highmore (Bul 183). At Vivian he planted 5 pecks per acre of barley and 6 pecks of oats and rye (Bul 162).

Champlin also planted spring wheat at several dates between March 1 and June 1 on the Highmore Substation from 1912 to 1922 and at Brookings from 1913 to 1921. The optimum planting date was late March and early April. Optimum seeding rates were 5 to 6 pecks for bread wheat and 6 to 7 pecks for durum (Bul 201).

Champlin seeded winter wheat at rates of 2 to 8 pecks per acre at Brookings from 1913 to 1922 and at rates of 2 to 6 pecks at Highmore from 1916 to 1922 and at Eureka from 1913 to 1918. The optimum rates were 6 pecks at Highmore and Brookings and 5 pecks at Eureka. He also planted the crop on several dates between mid-July and mid-December. The optimum dates appeared to be early September when planted in corn stalks and mid-September when planted on fallow (Bul 200).

From 1913 to 1915 Champlin seeded Primost flax on five dates at the Highmore, Eureka and Cottonwood Substations. John Martin followed the same procedure at the Belle Fourche Field Station at Newell. In each case the yield was highest from the earliest seeding date--April 1 at Highmore, April 15 at Cottonwood and Eureka and May 2 at Newell. Yield declined with each succeeding date. It was suggested that flax be planted as soon as the seeding of spring wheat, barley and oats was completed. The suggested seeding rate was 2 pecks per acre for most areas, but might be as low as 1 peck in drier areas (Bul 169).

The recommendation for seeding flax in April, made in 1916, was reaffirmed in 1924. However, a rate of seeding experiment conducted at Highmore during 1917-1924 indicated that flax yields increased as seeding rates increased up to 20 quarts (2 1/2 pecks), the highest rate tested (Bul 213).

Winter rye was planted on 10 dates at 2-week intervals between July 15 and December 1 at Highmore from 1917 to 1925. Highest yields were obtained by planting between September 1 and October 1 (Bul 220).

A bulletin written in 1927 summarized dates of seeding experiments for oats at Highmore; spring wheat, durum and barley at Brookings and Highmore; and flax at Brookings, Highmore, Eureka and Cottonwood. It recommended these planting dates: March 15 for hard red spring wheat, March 15 to April 15 for durum, April 1 to May 1 for oats and April 15 for flax (Bul 230).

During the 1970s the best rates of seeding were 3 to 4 pecks per acre for flax, 4 to 5 pecks for hard red spring wheat, 5 to 6 pecks for durum and barley and 8 to 10 pecks for oats. Best crop yields were obtained when spring wheat was seeded as early as weather and soil conditions permitted, followed in order by durum, barley, oats and flax. Optimum seeding dates were late March for hard red spring, early April for durum, mid-April for barley and oats and late April for flax (FS 383, 384, 485 & 488).

Winter wheat and rye did best when planted in September, but varieties of winter wheat susceptible to wheat streak mosaic sometimes suffered losses from the disease if planted before September 10 in northern counties and September 15 in southern counties.

Corn

Corn was planted at Brookings for 30 con-

secutive working days beginning May 1, 1888. Only corn planted on the first several dates was mature when frosted on September 11 (Bul 9).

In 1918 it was suggested that corn be planted at the rate of 8 acres per bushel--almost three kernels per hill for corn checked at a 42-inch spacing--if being grown for grain, but that a rate of 6 acres per bushel might be better for silage (Bul 181).

Brookings and Highmore

In 1945 A. N. Hume initiated a 10-year study on the Agronomy Farm and at the Highmore Substation. Early-, medium- and late-maturing corn hybrids were each planted at rates of two, three, and four kernels in hills spaced 42 inches apart in each direction on May 1 and May 20 from 1945 to 1949 and also on May 30 from 1950 to 1954. The corn was placed in a corn-oats-wheat rotation at Brookings and corn-wheat rotation at Highmore (Bul 455).

At Highmore a rate of 7,000 to 8,000 plants per acre was superior in yield on all planting dates and resulted in good quality corn during 5 favorable years. Early hybrids were definitely superior during dry years and with higher rates of planting. A medium-late hybrid with 6,000 plants per acre performed better when planted May 1 than when planted May 20 or May 30. However, the May 1 planting still produced soft corn during 5 of the 10 years (Bul 455).

At Brookings a hybrid of medium maturity with 10,000 to 12,000 plants per acre planted May 20 gave maximum yields of good quality corn. It was probable that corn planted on May 10 would have been equal. Planting on May 1 resulted in poor stands and lower yields, however, a later maturing corn produced as well when planted May 1 as when planted later. Planting on May 30 resulted in lower yields. A medium-late hybrid planted May 20 or May 30 produced wet or soft corn for some of the years (Bul 455).

Southeast Experiment Farm

From 1966 to 1968 F. E. Shubeck planted short-season and a full-season hybrids at populations of 10 to 18 thousand plants per acre in rows spaced 20, 30 and 40 inches apart. The full-season hybrid produced an average of 8 bushels more corn per acre than the short-season hybrid. Yields from 20- and 30-inch row spacings were equal and were 6 to 8 bushels higher than from 40-inch row spacings. Populations of 12,000 to 18,000 plants per acre produced about the same amount of corn which was somewhat higher than for 10,000 plants. Highest yielding combination for

these 3 years was the full-season hybrid at 16,000 plants per acre in 30-inch rows (8th Ann Rep, SE Farm).

The experiment was modified somewhat from 1970 to 1973. Plant populations were 12 to 20 thousand plants per acre and row spacings 30, 35 and 40 inches. The highest yields were obtained with 12,000 plants per acre during the dry year of 1970, 14,000 plants in the average year of 1971, and 20,000 plants of a full-season hybrid in 30-inch rows during the wet year of 1972. Highest yields were obtained with 18,000 plants of a short-season hybrid in 35-inch rows during 1973, a year with above average spring moisture and low rainfall in August. For the 4-year period, highest average yields were obtained with 12,000 to 14,000 plants per acre of a full season hybrid in 30-inch rows (13th Ann Rep SE Farm).

Over the 8-year period, 1966 to 1973, the most corn was produced with 14,000 plants per acre of a full-season hybrid in 30-inch rows (13th Ann Rep SE Farm).

In other experiments at the same location, corn was planted on four dates--late April to early June--each of 2 years. In general, the best yields were obtained by planting between May 9 and 20. Greatest response to fertilizer (20 to 30 bu/A) was obtained from plantings made on April 26. However, yield was still about 5 bushels lower than from fertilized corn planted about 2 weeks later (9th Ann Rep SE Farm).

Northeastern Research Farms

From 1969 to 1973 Quentin S. Kingsley planted corn at plant populations of 9 to 21 thousand plants per acre in 30- to 40-inch rows on the Whetstone Valley Research Farm near Twin Brooks. Highest average yields were obtained by planting 15,000 plants in 40-inch rows, 15,000 to 18,000 in 36-inch rows, and 18,000 in 30-inch rows.

From 1969 to 1972 Kingsley and D. B. Shank planted 12 to 16 thousand plants of five hybrids in 30-, 35- and 40-inch rows on the Northeast Research Farm near Watertown. Average yields from 16,000 plants were 4 bushels higher than from 12,000 plants in each row spacing. Likewise, yield from each population density was 6 bushels per acre higher in 30-inch rows than in 40-inch rows. In 1972, a wet year, 16,000 plants produced about 5 bushels more than 14,000 plants and 10 bushels more than 12,000 plants in each row spacing (PSP 11).

Miscellaneous Experiments

In experiments at Brookings, Shank learned that 10 hybrids yielded essentially the same

whether planted at rates of 15,000 or 17,800 plants per acre.

In other experiments conducted on private farms in Northeast South Dakota, plant populations of 16,000 to 20,000 plants produced higher yields under higher than average rainfall, but 8,000 plants produced maximum yields under drier conditions.

Irrigation

D. B. Shank planted 6 to 12 hybrids at plant populations of 10 to 23 thousand plants per acre, under irrigation, in three experiments on the Redfield Irrigation Farm. Yields from 14,570 plants were higher than from 10,000 plants and equal to yields obtained from 19,360 and 23,000 plants per acre (Cir 107).

L. O. Fine planted four hybrids at plant populations of 12 to 32 thousand plants per acre on a private irrigation farm near Yankton and obtained maximum yields from 16 to 32 thousand plants per acre (Bul 517).

Sorghum

In 1917 it was suggested that 25 to 30 pounds of sudangrass be planted in 6-inch rows or 15 pounds in 12-inch rows. The suggested rates for amber cane were 4 to 6 pounds per acre in 36- to 42-inch rows or 40 pounds if seeded solid. The optimum time of seeding at Brookings and Highmore was June 1 (Bul 174).

During the 1970s the best time to plant sorghums was after the soil warmed to 65°F. Sorghum could be planted as early as May 15 but was usually planted between May 20 and June 10. Some early varieties of grain sorghum could be planted as late as June 15. Sudangrass and sorghum-sudan hybrids, used for hay production or fall pasture, could be planted as late as July 10.

Best rates of seeding for grain sorghums were four to seven seeds per foot of row in drier areas, six to nine seeds per foot in higher rainfall areas or for a plant population of 10,000 plants per acre under irrigation (FS 308).

For sudangrass, the best rates were 20 to 25 pounds per acre for solid seedings and 12 to 15 pounds for 12- to 14-inch rows. Best rates for sorghum-sudan hybrids were 15 to 20 pounds for solid seedings, 12 to 15 pounds for 20-inch rows, 10 to 12 pounds for 30-inch rows and 6 to 8 pounds for 36- to 40-inch rows. Forage sorghums used for silage produced more when 8 to 10 pounds of seed per acre were planted in rows spaced 30 to 40 inches apart (FS 589).

Perennial Forage Crops

In 1910 C. Willis and J. V. Bopp suggested that 10 pounds of alfalfa seed could produce over 50 plants per square foot and should be enough. They indicated that farmers planting 15 to 25 pounds of seed per acre were being wasteful. They also suggested seeding "medium early" to give alfalfa seedlings a better chance of competing with weeds and so they are large enough to withstand a smaller supply of moisture in mid-summer (Bul 120).

In 1940 E. L. Erickson planted alfalfa at rates of 2 and 4 pounds per acre on Agronomy West Farm. However, in 1946, it was suggested that 12 pounds per acre be planted April 1 to 10, at a depth of 1/4 to 1/2 inch on medium to heavy textured soils and at 1 inch depth on sandy soils (Bul 283).

During the 1960s it was stated that 4 1/2 pounds of pure live alfalfa seed contained enough seed to plant over 20 seeds per square foot. If all seeds produced plants that would be 900,000 plants per acre. M. D. Rumbaugh showed that 300,000 plants per acre gave maximum yields in Eastern South Dakota. It was assumed that fewer plants were needed in drier areas and perhaps as few as 50,000 under some conditions.

Seeding suggestions at that time indicated that 4 1/2 pounds would be enough seed if good seeding techniques were used. However, most producers did not use the best planting procedures and a rate of 6 1/2 pounds was recommended.

C. R. Krueger and L. H. Hanson planted three alfalfa varieties at four seeding rates at three locations in 1971. Rates of 4 to 16 pounds of pure live seed were planted with a cultipacker seeder on a sub-irrigated field of the Gail Erickson farm near Gayville, on the irrigated Agricultural Engineering Farm near Brookings, and on dryland at the Pasture Research Center near Norbeck. Plant counts were made during June and October of the seeding year, during April of the next 3 years and in October 1976. Forage yields were obtained during the seeding year and the next 3 years.

Initial plant counts indicated a direct relationship between plant density and seeding rate. However, plant numbers decreased. By the end of the third year there were only 12 to 14 plants per square foot for the four seeding rates.

Yield was somewhat higher for the highest rate of seeding and somewhat lower for the lowest rate during the first year. During the next 3 years the three highest rates of seeding produced similar yields. Over the 4-year

period the 4-pound seeding produced 1 1/2 tons less than the other rates, indicating that the optimum rate may have been between 4 and 8 pounds of pure live seed when planted with the best seeding methods known.

METHODS OF SEEDING

From the very beginning, most major crops were seeded in different ways to determine the best ways to obtain a stand and maximum yield.

Small Grains

In 1889 Luther Foster expressed a preference for using a "roller press drill" instead of broadcasting on top of the ground for small grains because seed planted with a drill was protected from the wind and germinated more quickly. Less seed was required and weeds were less troublesome (Bul 11). The next year at Brookings, five 1-acre plots were each seeded to spring wheat with the drill or broadcast and harrowed in. Grain came up first on the press-drilled plots, had a more uniform stand, stood earlier and headed and ripened more evenly. On dryland much of the seed planted by broadcasting failed to germinate. However, average wheat yields were 25.3 bushels on drilled plots and 24.3 on broadcast seeded plots (Bul 17).

In 1890 at Brookings, Foster drilled Blue-stem wheat east and west, north and south, or cross drilled in both directions at the rate of 5 pecks per acre. Though no differences were noted visually, yields were 14.7 bushels per acre for east-west, 12.3 for both directions and 11.2 for north-south seedings (Bul 21).

During the early 1900s, the 3-row method of planting small grains and flax was devised for use in drier areas. The crop was seeded in groups of three rows spaced 6 or 7 inches apart in the group. Groups were spaced 30 inches apart and the area between groups was cultivated. Yields from this system were lower than from drilling in 6-inch rows from 1912 to 1915 for flax at Newell (Bul 169), during 1914 at Vivian for oats (Bul 162), and from 1914 to 1917 at Cottonwood for barley (Bul 183).

In 1916 Hume and Champlin suggested that flax be seeded with a press drill at a depth of 1 inch (Bul 169).

"Barley should always be seeded with a grain drill," was the recommendation in 1919. It should be seeded about 2 inches deep and somewhat deeper in dry, loose soil than in wet, compact soil (Bul 183).

In 1923 and 1924, wheat and flax were seeded separately in two plots and seeded

together in another at half the seeding rate for each. Both crops produced lower yields in the mixture, but 2 acres of the mixture produced about 168% as much wheat and 83% as much flax as 2 acres where each was seeded separately (Bul 213). This practice was followed by a limited number of wheat producers during periods when flax prices were high.

During the 1970s it was recommended that all small grains and flax be seeded with a grain drill. A press drill was preferred over the ordinary drill for spring planted grains, especially flax, and a deep-furrow drill was recommended for winter wheat. Suggested seeding rates were given for use with a drill with the added comment that rates be increased 20 to 30% for broadcast seedings.

Noble oats was planted by F. E. Shubeck at rates of 2, 3 and 4 bushels per acre on the Southeast South Dakota Experiment Farm in 1977. Each rate was planted with a grain drill and broadcast seeder. Though there was a small, but consistent yield increase as seeding rates increased for both seeding methods, the differences were insignificant. Yields ranged from 61 to 65 bushels per acre on drilled plots and 59 to 66 for those seeded broadcast (17th Ann Rep SE Farm).

Small-Seeded Crops

In 1910 Willis and Bopp discussed alfalfa production. They emphasized the value of good quality seed and the need to use a weed-free field, a disk, harrow and even a cultipacker when preparing the seedbed. They suggested that it be seeded at a shallow, uniform depth with a grass drill, if available, or a grain drill. The best time to cut was when one tenth of the blooms were out (Bul 120).

A disk drill with disks spaced 1 foot apart was recommended in 1912 for seeding both fox-tail and proso millet at the rate of one peck per acre (Bul 135).

In the meantime, N. E. Hansen, a horticulturalist trained in the art of producing transplants of vegetables and fruits, developed a method of raising transplants of alfalfa. Seeds were planted in the greenhouse and seedlings transplanted to the garden where they were given ample space to develop and set a maximum amount of seed. As soon as the supply of seed had been increased sufficiently, it was sown in rows with garden drills and cultivated with a wheel hoe. The plants were dug with a tree digger and "heeled in" outdoors with manure over the top of the earth. He found that transplanting dormant plants was usually much better than transplanting from plots (Bul 141).

He then modified a transplanting machine used for tobacco, cabbages, tomatoes, sweet potatoes and other plants by widening the toe of the shoe to allow alfalfa roots to pass through (Bul 141). Transplanting one-year-old plants by machine was demonstrated at Ipswich on May 2, 1912, where plants were set at the rate of 100 per minute or 6,000 per hour. Demonstrations of machine planting were made first at Brookings, then Redfield, Big Stone, Eureka, McIntosh, Lemmon and Onida. Plants were set with plow, spade or hoe at Faith, Frederick, Philip, Blunt, Sansarc, Hilland, Hayes and other points in a strenuous 3-week alfalfa campaign. In the fall of 1912 the new machine was tested at Whitewood, Sansarc, Cottonwood and Philip (Bul 141).



Transplanting alfalfa seedlings in 1913.

In 1916 Hansen suggested that farmers plant alfalfa seeds in their gardens and produce their own transplants. If the garden were to be hand hoed, he suggested that 3 pounds of seed per acre be sown on 1 acre in 18-inch rows. If a horse-drawn cultivator was used for weed control, he suggested 1 1/2 pounds per acre on 2 acres in 36-inch rows. Either system would produce 300,000 plants, enough for planting a 60-acre field. He suggested that the seedlings be lifted in the fall and transplanted immediately or heeled in for the winter and planted the next spring (Bul 167).

Alfalfa was planted with and without a companion crop of oats, barley and winter rye on the newly established Vivian Substation in 1914 (Bul 162). Over a 9-year period, first-year yields of alfalfa were highest after being underseeded in oats, followed by barley and then rye (Bul 253).

In 1946 S. Garver suggested that alfalfa be sown without a companion crop under dry conditions, but where moisture conditions were favorable it could be seeded with a companion crop of flax or spring grain, sown at one half the usual rate. If drought conditions developed, he suggested that the crop be cut for hay. Oats, beardless wheat and smooth-awned

barley made good hay. However, better stands were obtained if flax was used as the companion crop. He also suggested that alfalfa be seeded in widely spaced rows in western counties (Bul 383).

In 1946 it was stated that the seedbed for alfalfa should be moist and firm and precautions should be taken to keep weeds from choking out seedlings. Greater uniformity of seed distribution and depth of planting was obtained when seeding with a mechanical drill. The clover or alfalfa drill was suggested as a good machine. However, a practical method was to mount the grass seeding attachment from a grain drill on the frame of a double corrugated roller with seed spouts extending down between the two rows of rollers and with a wheel mounted at the rear to drive the seeder (Bul 383).

In 1949 and 1950 alfalfa and grasses were planted at the Huron and Redfield Development Farms with a cultipacker seeder, which was believed to be the best implement (Cir 107).



Seeding alfalfa with cultipacker seeder.

C. R. Kruger and L. H. Hansen planted three alfalfa varieties on a sub-irrigated farm near Gayville, the irrigated Agricultural Engineering Farm near Brookings, and under dryland conditions on the Pasture Research Farm near Norbeck in Faulk County in 1971. Four methods of stand establishment were used: (1) oats companion crop harvested for haylage, (2) oats companion crop harvested for grain, (3) application of herbicide before planting and (4) no treatment except to clip weeds in June. Forage yields were determined for 4 years.

During the first year the highest yield of forage was obtained from treatment 1 that included oatlage. However, the number of alfalfa seedlings established was essentially the same for all methods of seeding and there were no differences in forage yield after the first year.

During the 1970s the best methods of planting small-seeded forages included the use of cultipacker seeder on clean cultivated fields. The seeder did not cover seeds if planted in areas covered with crop residue. The grass-

land drill was the best all-round seeder. Disk openers made it possible to seed in stubble of small grain or sudangrass, depth bands gave a uniform shallow depth, packer wheels firmed the seedbed, and agitators in the seed hoppers insured free flow of chaffy grasses.



Grassland drill for seeding forage crops,

Preplant herbicides or companion crops were used to control weeds. Companion crops were best used when planted at one-half the normal seeding rate and harvested for forage in June when there was not enough moisture to both produce a grain crop and maintain a stand of forage seedlings.

Corn

The conventional method of planting corn was to plow with a moldboard plow, disk and harrow and then plant. At first the corn was drilled; seeds were planted at regular intervals in the row. Then the technique of checking was developed. A wire with knots spaced at 42-inch intervals was stretched across the field. It was held in place by a steel stake at each end of the field. As the planter moved across the field, the wire fed through a fork. Each knot tripped the fork which caused the planter to drop two or three kernels in a hill. At each end the planter operator moved the stake so it would hold the wire properly for the next two trips across the field. When the corn came up it could be "rowed" both lengthwise and crosswise and could be cultivated in both directions.

Another method was tested at the Vivian Substation. Hard ground listing was compared with conventional planting for 10 years beginning in 1918. Experiments in which corn was drilled solid in rows and checked to permit cross cultivation were initiated by Manley Champlin. Average silage yields were slightly higher from listing, followed in order by checking and drilling (Bul 162).

At the end of World War I practically all the corn in the state was drilled or checked on plowing in the conventional method of

planting, except in the south central area where hard ground listing was more popular. It was suggested that plowing be done at a depth of 6 to 8 inches. Fall plowing helped give good labor distribution. Disking, harrowing and cultivating were suggested for preparing the seedbed and controlling weeds (Bul 181).



Listing corn at Vivian during 1920s.

There was very little change in corn planting methods until World War II. Tractors came into widespread use and a corn planter was developed that would "hill drop" corn without a wire. Farmers were reluctant to climb down to move the wire at each end of the field and now they could plant corn in hills without doing so, though the hills were not aligned in rows. However, by 1970 hill dropping was obsolete and farmers drilled their corn as was done a half century earlier.

CROP ROTATIONS

Studies involving crop rotations have been underway ever since Professor Chilcott established the first crop rotation experiment on West Farm at Brookings. During the spring of 1897, six 5-year rotations, three 4-year rotations, six 3-year rotations, three 2-year rotations and four plots of continuous wheat with no manure or 20 tons added every 1, 3 and 5 years were established. Nine of the rotations were (1) flax-barley-millet-wheat-corn-oats, (2) wheat-fallow-wheat-corn, (3) wheat-barley-peas-wheat-corn, (4) wheat-corn, (5) wheat-oats, (6) wheat-corn-oats, (7) wheat-wheat-fallow, (8) wheat-fallow and (9) wheat-corn. In 1902 two more rotations, that included 2 or 3 years of brome grass, were added (Bul 79).

During the first 5 years, wheat yields were highest when it followed fallow or corn,

lowest following oats, and intermediate after wheat, millet or peas. When oats followed corn, its yield was higher than when it followed wheat; barley produced more after flax than when it followed wheat (Bul 79).

Several rotations with 3 years of small grain or millet and one year of corn were unsatisfactory. The best 5-year rotations included two cultivated crops--either corn, potatoes, fallow or a green manure crop (Bul 79).

Highmore, 1905-1932

In 1905 W. A. Wheeler and S. Balz established eight 3-year rotations on 1/10-acre plots. That fall 16 plots were prepared to test different methods of tillage for producing corn, wheat, barley and oats (Bul 96). The series of rotation plots started in 1905 was extended in 1906 to include 94 1/10-acre plots. The experiments were conducted in cooperation with the USDA, and rotations were planned so results could be compared with those obtained in North Dakota, Nebraska, Kansas and Texas (Bul 101).

They were modified by C. Willis in 1908. He used thirty-four crop sequences in 3- to 5-year rotations. Some of the crop sequences were (1) wheat-oats-corn, (2) wheat-oats-corn-fallow, (3) oats-barley-corn, (4) corn-wheat-brome-brome-oats and (5) corn-oats-green manure crop-wheat. The number of rotations was increased by using different green manure crops--rye, peas, sweetclover--and by using different methods of seedbed preparation--disking corn stalks or plowing in spring or fall (Bul 115).

These rotations were modified by A. N. Hume during 1912 to include only 10 rotations (1) corn-wheat-peas-sorghum-oats, (2) corn-small grain, (3) corn-small grain-legumes, (4) corn-rye-sweetclover-millet-small grain-green manure crop of rye or rape, (5) fallow-small grain, (6) corn-oats-wheat, (7) corn-barley-bromegrass-alfalfa, (8) corn-small grain and clover, (9) continuous small grains and (10) corn-wheat-sweetclover (Bul 272).

However, Hume had arranged it so that each crop occupied a 1-acre block and it was possible to handle each crop in several ways--plant more than one small grain or green manure crop, or use different treatments of manure or fertilizer in the 1/10-acre plots within the block. Two rotations, (11) potatoes-flax-alfalfa and (12) corn-oats-winter wheat, were added in 1913 (Bul 272).

In 1932 Hume reported that the best crop rotations included a cultivated crop, a small grain crop and a legume. "Financial returns

from wheat, barley, oats and flax were comparatively high, and they severally furnished a wide range of succession following any cultivated crop." All produced higher yields when planted on fallow or after a row crop (Bul 272).

Highest yields of corn, winter rye, emmer, spring wheat, barley and winter wheat were obtained when a legume (usually sweetclover) was included in the rotation (Bul 272).

The rotations were suspended in 1936 because of a lack of funds (Bul 325).

Cottonwood 1909-1936

Clifford Willis, superintendent of substations, established crop rotation experiments at the Cottonwood Substation in 1909 which were revised by A. N. Hume in 1912.

The revised rotations included (1) corn-oats-green manure crop-alfalfa (5-10 yrs)-potatoes-flax, (2) corn-wheat-oats, (3) corn-wheat-sweetclover, (4) sorghum-barley-legume, (5) sunflowers-barley-legume, (6) sorghum or small grain-legume hay-corn-small grain-legume, (7) corn-wheat, (8) continuous small grain and (9) forage crop (millet, cane or sudangrass)-oats (Bul 312).

Each crop was planted on a 1-acre block and special practices were conducted on 1/10 acre plots within the block. Special practices included more than one rate of manure application, fertilizer rates, small grain, planting methods, plowing depth and others (Bul 312).

In 1932 results indicated that legumes (sweetclover and alfalfa), small grains (wheat, barley, oats, winter rye and flax), and cultivated crops (corn and sorghum) could be profitably raised in the area if they were raised in the proper rotation. Small grains for example, were more productive if they followed a cultivated crop (Bul 312).

Rotation number 6 appeared to be one of the best rotations. Farm value per acre for spring or winter wheat, oats, winter rye, sorghum and sweetclover was higher in this rotation than in any of the others. However, value was highest for corn in rotation 2, for barley in rotation 4, and for flax and potatoes in rotation 1. The value of crops which were raised in the most favorable rotation, for the crop, was highest for potatoes, followed in order by sweetclover, alfalfa, spring wheat, barley, rye, oats, flax, sorghum, corn and winter wheat. Value of crops were \$12.00 per acre for alfalfa, \$8 to \$9 for most small grains, \$7.50 for grain sorghum, and \$6.60 for corn and winter wheat (Bul 312).

Amber cane was the most valuable forage followed in order by alfalfa, sweetclover, oats, sudangrass, millet, corn, western wheatgrass and smooth brome grass. Though sweetclover, millet, oats and sudan, in that order, produced more forage than alfalfa, lower value per ton meant lower value per acre. Values ranged from over \$17.00 for sweetclover; \$9 to \$10 for legumes; \$7 to \$8 for oats, sudangrass and millet; \$3.50 to \$4.00 for corn and western wheatgrass; to \$1.36 for brome grass (Bul 312).

The experiment was discontinued in 1936 because of lack of funds (Bul 325).

Eureka and Vivian

Clifford Willis established crop rotations at the Eureka Substation in 1908 that were modified by A. N. Hume in 1912 (Cir 103). It is assumed that the rotations were similar to those established at Highmore and Cottonwood.

In 1914 Manley Champlin established row crop-small grain-legume rotations at the Vivian Substation. Since each crop was planted in 14-acre blocks, corn and kaoliang sorghum were used as row crops on 2-acre plots. Oats, barley, wheat and rye were used as small grains and sweetclover, peas or alfalfa as the legume (Bul 162).

Rotations of continuous corn and corn-small grain-alfalfa were established in 1920 and summarized 10 years later (Bul 253).

Continuous Corn

Vivian 13 (selected from Minn 13), a yellow dent and Rainbow Flint were planted in 1-acre plots by listing, checking and drilling. Half the plots were fertilized with manure (Bul 253).

At the end of 10 years the following observations were made: (1) flint corn produced an average of 20% (1T) more silage than yellow dent, (2) listed corn produced 11% (637 lb) more silage than checked corn which produced 2% (140 lb) more than drilled corn, and (3) unmanured corn produced 16% (851 lb) more than manured corn (Bul 253).

Corn-Small Grain-Alfalfa

Nine 7-acre fields were used--3 fields for each crop. Rainbow Flint, Vivian 13 and All Dakota corn were planted each, in a 7-acre field. Cole oats, Odessa barley and Advance winter rye, also, were seeded in 7-acre fields underseeded with alfalfa. Alfalfa was grown on the other three fields (Bul 253).

After 10 years the following observations were made: (1) Corn produced grain in only 2

years and could be more profitably used as silage until better varieties were found. (2) With the small grains, oats produced the most bushels per acre followed by barley and then rye, but barley was first in pounds per acre, cash value and feed value. (3) Alfalfa yields were highest when underseeded in oats, followed by barley and then winter rye (Bul 253).

Newell 1909-1948
J. J. Bonnemenn

Crops were grown on dryland under planned sequences at the Belle Fourche Field Station beginning in 1909. Winter wheat, spring wheat, oats, barley and corn were grown in 2-3- and 4-year rotations of (1) small grain-fallow or corn, (2) small grain-small grain-row crop or fallow and (3) small grain-row crop-small grain-fallow or green manure crop. The same crops were grown in 5- or 6-year rotations which included perennial grass or legume crops (Cir 85).

During the first 40 years it was determined that:

1. The most productive and drought-resistant crops were those used for feeding livestock. Hay crop failures, which approximated 11%, were caused by difficulty in securing stands in dry years.

2. Alfalfa produced an average yield of almost 1 ton per acre, but yielded less than 1/2 ton 50% of the time.

3. Grasses such as smooth brome grass and crested wheatgrass produced about 1/4 ton per acre less than alfalfa.

4. Forage sorghums were dependable feed crops. They produced more forage than any other crop and failed completely in only 2 years.

5. Small grains were fairly well adapted with crop failures of about 18%. Spring wheat failed during 7 years because of drought, but spring wheat and winter wheat were the most important cash crops. If it survived the winter, winter wheat did best when planted on fallowed land.

6. Winter rye was hardier than winter wheat, but less productive during years that winter wheat survived.

7. Barley produced more pounds of grain per acre than any other small grain, but was not much higher than for oats.

8. Flax produced good yields, but failed completely more often than small grain crops.

9. Corn produced less grain than either barley or oats, but produced almost as much stover as sorghum.

10. A preferred cropping pattern was one year of row crop or fallow and 2 years of small grain (Cir 85).

1942 Crop Rotations

Leo F. Puhr established a series of crop rotations on the new Agronomy Farm at Brookings. With an improved budget for substations, he also established new rotation experiments at the Highmore and Eureka substations.

The rotations at Brookings were (1) corn-wheat-oats (changed to corn-oats in 1958) with and without fertilization, (2) corn-wheat-sweetclover (expanded in 1957 to include corn-wheat-red clover), (3) corn-wheat-oats & sweetclover, (4) corn-flax-alfalfa and (5) corn-flax-corn-oats.

Sweetclover as a catch crop in small grain preceding corn in a corn-wheat or a corn-wheat-oats rotation increased yields, probably because it added nitrogen. Corn with nitrogen fertilization or in a rotation with a legume had higher yields than in a rotation with alfalfa, probably because alfalfa depleted subsoil moisture (Bul 508).

The rotations at the Highmore Substation were (1) continuous wheat, (2) corn-wheat, (3) sorghum-wheat, (4) corn-wheat-sweetclover and fallow, (5) sorghum-wheat-sweetclover and fallow and (6) wheat-fallow.

Wheat yields decreased as much as 9 bushels in 13 years when grown continuously, decreased slightly in the 2-year rotations with corn or sorghum and remained about the same in the wheat-fallow and 3-year rotations. Highest wheat yields were obtained on wheat-fallow and corn-wheat-clover rotations followed in order by the sorghum-wheat-clover and corn-wheat rotations, the sorghum-wheat rotation and finally by continuous wheat. Corn yields were 8 to 12 bushels per acre higher than sorghum yields and both produced more grain in the 2-year rotation than in a 3-year sequence (Cir 124).

The same rotations were established at Eureka except that continuous wheat and wheat-fallow were omitted and oats was used instead of wheat.

Crop yields of corn and sorghum were similar. Oat yields were 2.5 bushels per acre greater when following corn in the 2-year rotations and 2.6 bushels greater when following sorghum in the 3-year rotations. However, oats yield was 50% higher in the 3-year rotations. Corn yield in the 2-year rotation was equal to that in the 3-year crop sequence (Cir 103).

Other Crop Rotation Studies

During the 1960s Fred Shubeck compared continuous corn with rotations of corn-oats and corn-oats-alfalfa on the Southeast South Dakota Experiment Farm. Continuous corn, adequately fertilized, had the highest cash return for any cropping sequence. Nitrogen gained from 4 years of the legume did not compensate for the corn yield reduction caused by the decrease in subsoil moisture (Shubeck).

CHAPTER XXIII FORAGE LEGUMES

M. D. RUMBAUGH

Major emphasis was placed on forage crops during the 1890s and early 1900s. Though the USDA maintained an alfalfa research station at Redfield, Experiment Station personnel placed more emphasis on small grain and corn for about a quarter of a century. Finally, in the late 1940s legume became an important aspect in the Agronomy Department.

PERSONNEL

As with other crops, forage legumes were handled by botanists until 1908. However, N. E. Hansen, a horticulturist, spent considerable time with alfalfa for about 2 decades. C. J. Franzke and M. Fowlds worked with all crops but devoted relatively little time to forages. E. L. Erickson had charge of the Seed Testing Laboratory, weed control and forage projects. Though he had an alfalfa rate-of-planting experiment and variety performance trials with alfalfa and sweetclover, his major forage crop endeavors were with kochia.

Finally, in 1947 M. W. Adams was hired to devote full-time to forage legumes. Adams was replaced by Rumbaugh. When Rumbaugh left, J. G. Ross had charge of all forages with G. L. Holborn as an assistant for alfalfa. In 1979 A. A. Boe took charge of legume investigations.

The USDA established the Redfield Station in 1914 to conduct alfalfa investigations. Incomplete records indicate that Samuel Garver was at the station during the first few years. E. S. McFadden was at that location in 1930 and may have been there until it was closed in the mid-1930s.

Staff Members

J. M. Aldrich	1889-1891
T. A. Williams	1891-1896
D. A. Saunders	1896-1903
W. A. Wheeler	1904-1907
N. E. Hansen	1907-1916
Sam Garver	1914- ? (USDA)
M. Fowlds	1915-1939
E. S. McFadden	1929-1935 (USDA)
C. J. Franzke	1924-1939
E. L. Erickson	1939-1947
J. G. Ross	1947-1981
M. W. Adams	1947-1958
M. D. Rumbaugh	1960-1977
G. L. Holborn	1977-1979
A. A. Boe	1979-

Graduate Students

John H. Miller	M.S. 3/1/46-3/19/48
Wesley A. Dunlap	M.S. 1953-1956
Harry A. Geise	M.S. 10/1/54-4/1/58
Sadi A. Tamini	Ph.D. 1960-1962
Verkatrao Koropaty	M.S. 1975-1977

LEGUMES IN SOUTH DAKOTA

The potential contribution that forage legumes could make to the agricultural economy of South Dakota was recognized at an early date by both the farmers in the state and by scientists at South Dakota Agricultural College. In the First Annual Report of the Agricultural Experiment Station in 1888, Luther Foster, Superintendent of Agriculture, told of the testing of nine kinds of forage legumes. These included white and red clover, sweetclover, trefoil, and alfalfa, all of which were destined to become crops of considerable economic importance in the state.

Alfalfa was known to be a superior forage when it was introduced into the Black Hills by Seth Bullock in 1881. Knowledge of proper management in the South Dakota environment was, however, lacking. In 1888, studies were initiated at the Experiment Station on such problems as seeding rates and methods. Pest problems were encountered that first year. Luther Foster wrote that alfalfa growth was good, "save one backset caused by the ravages of the black beetle in June, when they left the potato field and came in full force to the alfalfa." Lack of winterhardiness also was a problem.

In 1896 the Hunter-Salzer Farm was established near Mellette to test forages under irrigation. Either botanist Thomas A. Williams or agriculturist E. C. Chilcott planted alfalfa, Mammoth and medium red clover and alsike and white Dutch clover (Bul 59).

Three years later the Cooperative Range Field Station was established near Highmore for the express purpose of testing forage crops for drought resistance. Saunders planted 1/4-acre plots of Turkestan alfalfa, lespedeza and hairy vetch with seed obtained by N. E. Hansen in Europe and Asia (Bul 66).

W. A. Wheeler, another botanist, succeeded Saunders and had charge of forage investigations at Brookings and Highmore from 1904 to 1907. He changed research emphasis somewhat. In 1904 he and Sylvester Balz, superintendent at Highmore, planted a large number of square-

rod plots of grasses, clovers and alfalfa. They included 30 plots of alfalfa (Bul 96). His efforts complemented those of Hansen who also was active in promoting alfalfa research and culture at the time.

From 1907 to 1916, Wheeler was secretary and manager of the Dakota Improved Seed Company. In that capacity he actively cooperated with scientists in many states and supplied them with seeds of his alfalfa selections.

While Clifford Willis was chief in the Agronomy Department from 1908 to 1911, he planted alfalfa and sweetclover in the crop rotations he established at Brookings and the three substations.

On March 3, 1911, the South Dakota State Legislature appropriated \$2,000 to give limited trial of the new alfalfas collected by Hansen in 1906 and 1908. A few days later Hansen made an offer through the newspapers to send ten free plants to the first ten applicants in each county--the plants to be set in good garden soil far enough apart to allow thorough cultivation and encourage free production of seed. Some 800 applications were received. The offer was repeated in 1911 and packets of 100 seeds were distributed in 1912. Over 1500 farmers cooperated in the project (Bul 141).

Though many plants did not survive the drought that covered all of the state in 1910 and 1911 and part of it in 1912, and many plants were damaged by blister beetles, Hansen received reports from 49 farmers who had Semipalatinsk, 29 from Chernob, 11 from Omsk, 10 from Cossack and three each from Samara and Orenburg. Flower color varied, being variegated for Cossack, pale yellow or white for Chernob, yellow for Semipalatinsk, Orenburg, Samara, Omsk and Obb (Bul 141).

Cossack and Chernob were thought to be hybrids obtained by natural crossing of blue- and yellow-flowered alfalfas. The original plant of Cossack was found on the dry steppes of Voronezh province in southern Russia, the land of the Don Cossacks. Chernob also descended from a single plant. Both of the original plants were found growing wild by Professor V. R. Williams, Imperial Agricultural College, Moscow (Bul 141) in 1907 (Bul 383).

One Cossack plant was the champion seed producer in the farmer tests and yielded 41,430 seeds while one plant of Chernob produced 37,135. Plants of both varieties produced as many as 500 stems per plant and this became the standard for spaced plants in Hansen's selection program (Bul 141). The two strains were put together to form the variety Cossack as later distributed throughout South Dakota and the Great Plains (Ross).

"These alfalfas and clovers may be used in two ways," Hansen suggested. "One, as a cultivated crop for hay and pasture, and two, to introduce as wild plants into the native ranges of the Prairie Northwest where they will probably be able to hold their own with any plant now found there" (Bul 141).

During the summer of 1912, J. W. Wilson grazed yellow-flowered alfalfa with sheep and hogs. Sheep preferred alfalfa to alsike clover. Hogs that were fed corn on alfalfa pasture gained 28 more pounds in 41 days than hogs fed corn on brome grass pasture (Bul 141).

Alfalfa was one of the first crops planted on the Vivian Substation in 1914 (Bul 253).

The United States Department of Agriculture provided personnel and support for alfalfa research at Highmore and Redfield. Samuel Garver, an employee of the USDA, jointly conducted investigations with the Experiment Station staff.

In 1912, he and A. N. Hume concluded that average yields of hay from several alfalfa varieties were more profitable than average crops of wheat or corn at Brookings and equal to these crops at Highmore (Bul 133). Garver's career was summarized in an excellent bulletin he wrote, entitled "Alfalfa in South Dakota--Twenty-one years of research at the Redfield Station" published in 1946.

Forage legumes other than alfalfa were also being evaluated. Hume and Champlin reported on sweetclover management and utilization in 1914 (Bul 151). An intensive investigation of the physiological water requirements of sweetclover was conducted by Hume, Loomis, and Hutton in 1920 (Bul 121). The substations at Cottonwood, Eureka, Highmore and Vivian were important locations for forage crop testing and breeding in the period from 1920 to 1940.

Hansen's interest in alfalfa breeding continued until his retirement in 1936. Mathew Fowlds assumed responsibility for alfalfa breeding and studied the effects of self-pollination on plant vigor and fertility. By 1940 research was under the leadership of E. L. Erickson of the Agronomy Department. Plant characteristics of native legumes were being studied.

Interest shifted to those permitting adaptation as a dryland crop in the central and western parts of the state. *Astragalus*, *Hosackia*, *Lotus* and *Vicia* also were under study. The annual report of the director for 1943 stated that, "From these species, it is believed, will come plants adapted to the rangeland and capable of increasing the protein content of the pastureland and hay crops of that area."

The concept of alfalfa as a range legume in South Dakota originated with Hansen in 1913, and it was finally included in a breeding program in 1949 by M. W. Adams.

ALFALFA BREEDING

At first the "common" alfalfa strains originated in the southwestern states from seed stocks imported into California from Chile. They were not adapted to the severe winters of the Northern Great Plains and severe winterkill was a common occurrence.

Four sources of winterhardy alfalfa germplasm became available in the decade after 1900. The first was strains from the Black Hills which were undergoing natural selection as the less hardy plants died and the more hardy set seed. Then a hardy strain, Grimm, was discovered in 1900 in Carver County, Minnesota. A German immigrant farmer, Wendelin Grimm, had brought alfalfa seeds to the United States in 1857. Over the years this population had also become adapted to the rigors of northern winters and survived much better than common strains from the Southwest. It was first planted at Brookings in 1902. A similar adapted alfalfa was found growing near Baltic in 1905 by W. A. Wheeler. The fourth source of winterhardy alfalfas was the seed collected by N. E. Hansen during trips to Turkestan and Siberia.

All of these sources became important in alfalfa breeding and culture. Grimm achieved great prominence in the Northern United States and Canada. However, seed increase and distribution were slow, and as late as 1914 it was impossible to locate five carloads of Grimm alfalfa seed for use in Minnesota.

Seed from the Black Hills region was in demand because of its superior hardiness and was widely distributed at that time. These strains had been selected by nature and not by the application of modern genetic principals and plant breeding procedures.

The first alfalfa breeding program in South Dakota and one of the very earliest ones in the United States was conducted by W. A. Wheeler. His first plots were seeded in 1904 almost simultaneously with those of E. G. Montgomery at the University of Nebraska. Wheeler conducted research at Brookings and at Highmore during the 4 years he was employed by the Experiment Station.

Pedigree Rows

In alfalfa breeding, seed from various sources was sown in selection rows. Rows were 3 feet apart with plants spaced at 1-foot intervals in the rows. One hundred or more

plants were grown in each row. Seed was harvested from the best plants and seed from each plant was sown in separate centgener or pedigree rows with the spacing as in selection rows. In 1905 Wheeler and S. Balz planted selection rows of eleven different kinds of alfalfa at Highmore. Each row contained 130 plants that were observed. A total of about 150 plants were selected. Seed from them was harvested for planting the next year (Bul 96). In 1906 pedigree rows were planted from the seed of selected plants from eight of the selection rows. However, there was so much labor involved that they decided to concentrate on only four varieties: Grimm, Baltic and two selections from Turkestan (Bul 101).

In 1905 alfalfa seed obtained from 19 sources was planted in square-rod plots at Highmore (Bul 96). The next year over 6,500 alfalfa seedlings were transplanted at Highmore. N. E. Hansen produced the transplants from seed obtained at 19 locations, mostly in Europe and Asia (Bul 101).

Production of at least 500 stems per plant was a standard adopted by Hansen for selecting plants to be used in breeding (Bul 141).

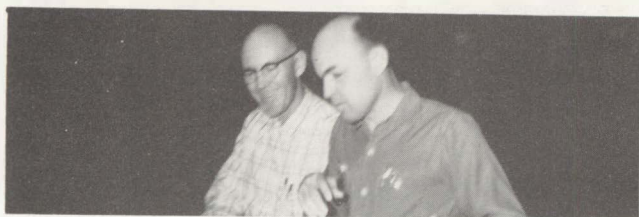
Cross Breeding

W. A. Wheeler and N. E. Hansen disagreed over the merits of selection and hybridization as breeding techniques for increasing hardiness and adaptability. Hansen had been present when the first paper on hybrid vigor was presented before the American Breeder Association, now the American Genetic Association, and was impressed with the potential use of hybrids. Accordingly, he made alternate plantings of Turkestan alfalfa, a blue-flowered type, and Semipalatinsk, a yellow-flowered type (Ross).

In the spring of 1914 Hansen set 1-year old plants at Brookings. Plants of two varieties were planted alternately by the machine transplanting method. Two men rode on a modified vegetable crop transplanter and planted alfalfa seedlings that had been raised the previous year and stored over winter. In some cases one man set a blue-flowered variety and the other planted a yellow-flowered variety so that they occurred alternately in the same row and could readily cross pollinate. Seed from each variety was harvested separately, and it was expected that they would produce plants with varigated flower color (Bul 159).

This planting was partially destroyed for the construction of a golf course and an ice skating rink during the 1920s and 1930s. In 1949 M. W. Adams secured germplasm for the alfalfa breeding program from the remnants of those plantings. The last plants were des-

troyed for the construction of the Student Union parking lot that was completed in 1973.



J. G. Ross and M. W. Adams.

Ladak

The Redfield Station was established by the USDA in 1914 to introduce and develop more productive and cold-resistant alfalfa varieties for the area. Also, research was to determine methods of establishing, managing and maintaining stands that would maximize hay and seed yields (Bul 383).

Ladak was developed from seed introduced from Leh, British India. It appeared so promising that 700 pounds of seed produced from increase blocks in 1916, 1919 and 1921. All of this variety grown in the United States was derived from seed produced at Redfield. Seed of Cossack was also increased at Redfield and made available to farmers in the state (Bul 383).

Synthetic Varieties

During the 1940s plant breeders began developing varieties by planting two or more clones, possessing desirable characteristics, close together so that pollen from each plant could fertilize some flowers of each of the other plants. The seed from all plants was bulked. Some was planted and observed. If the resulting plants were satisfactory, the remaining seed became seed for a synthetic variety.



Adams discussed alfalfa breeding in greenhouse.

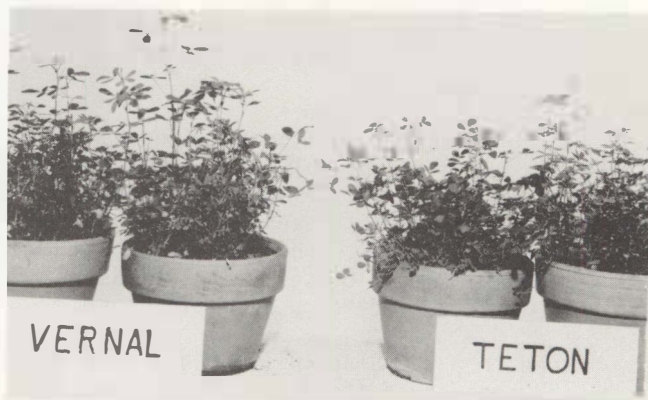
M. W. Adams used this method to develop the pasture varieties Teton and Travois. Teton

was derived from plants that descended from the crosses made by Hansen in 1914 when he planted blue-flowered and the yellow-flowered alfalfas in a crossing block (Bul 469).

In 1949 Adams selected several plants that descended from the cross. After two generations of intercrossing and progeny testing, four selections were retained as the basic clones to produce the new strains (Bul 469).

Selection was based primarily on three attributes: resistance to bacterial wilt, resistance to common leafspot and low wide crown. When possible, selection was made for vegetative vigor, seed producing potential and general freedom from foliage disease (Bul 469).

Teton was characterized by a wide spreading crown and slow regrowth capability. Ranger, Vernal and other hay-type varieties had been bred to produce regrowth quickly after being cut for hay so that two or three crops of hay could be harvested in a year. Food reserves in the roots were used to produce this regrowth. When grazed, the frequent removal of top growth caused a constant drain on root reserves. Stands were often depleted by grazing in 2 or 3 years.



Comparison of regrowth of Vernal and Teton.

Teton produced a good first crop of forage, but recovered slowly. Though it did not produce a good second cutting of hay, its root reserves were not depleted, and it withstood heavy grazing. At Eureka the stand was not adversely affected by 13 years of grazing by sheep.

Stand density was increased vegetatively from its spreading crown. The ability to spread and withstand heavy grazing made it an excellent pasture-type variety. It was the second such variety ever developed.

Travois was developed in a manner similar to the program resulting in Teton. The source nursery included naturally occurring hybrids between Cossack and three yellow-flowered

strains from an old stand in Perkins County. Hansen collected the yellow-flowered strains near Semipalatinsk and, in 1910 or 1911, distributed transplants or seed to a rancher (Bul 525). Other plants in the nursery were obtained from Swift Current, Saskatchewan.

Many plants were evaluated for lateral spreading by proliferating roots. Twenty-three clones were progeny tested for lateral spread, growth habit, speed of recovery after cutting and resistance to bacterial wilt and other foliage and stem diseases. Ten plants were kept and planted in close proximity so that they could cross pollinate. Seed from the crossing was used for the synthetic variety Travois (Bul 525). Most of the breeding work for Travois had been completed when Adams left the Agronomy Department in December 1958 to join the staff at Michigan State University. M. D. Rumbaugh replaced him in 1960 and completed the development work. Travois spread from proliferating roots and had a slow regrowth characteristic.

Adams and Rumbaugh were agronomists and relied on Dr. George Semeniuk of the Plant Pathology Department for the disease evaluations made in the development of both the cultivars Teton and Travois.

Rumbaugh initiated a breeding program to develop a high seed producing pasture-type alfalfa that would not cause ruminants to bloat. Though neither Teton nor Travois had been known to cause bloat, it was felt that they possessed the potential. Both were poor seed producers.

When Rumbaugh left the Experiment Station in February 1977, he had developed two lines for possible release as new cultivars. T2-5 was developed from five clones of Travois but it had more blue flowers. D2 was a yellow-flowered synthetic produced from a large number of yellow-flowered plants. Both were selected for low, stable foam volume and high seed production.

Seed of both was planted at the North Farm, near the Animal Nutrition Unit, during the fall of 1977. They were grazed with 10 ewes on a 1/4-acre plot to evaluate them for bloat and grazing persistence. Both lines

are still being evaluated for possible release.

During this time South Dakota materials were included in three germplasm releases, NC-83-1, NC-83-2 and C-3. Several elite breeding clones were also made available to other breeders. The Experiment Station participated in testing and releasing Dawson alfalfa which was bred in Nebraska.

HISTORICAL ACREAGE AND PRODUCTION

The number of acres harvested for all types of hay fluctuated as livestock numbers changed. Over 4 million acres were harvested from 1915 to 1925, but the acreage was gradually reduced as the economy declined. Acreage decreased to less than 3 million acres during the depths of the depression in the 1930s. Many cattle were slaughtered because of the New Deal farm program in the 1930s, and tractors replaced draft horses.

However, as livestock numbers built up in the 1940s and 1950s, more acres of hay were harvested. During the 1960s thousands of acres of perennial forages were planted in the Federal Soil Bank Program, but could not be harvested for hay. Though acres of forage crops increased, the number harvested for hay decreased.

Since South Dakota farmers started planting alfalfa, there has been a gradual increase in the number of acres harvested for hay. The acreage reached the 1/2 million mark in 1920, the 1 million acre level in 1952, and 2 million in 1955. After that it fluctuated between 2 and 2 1/2 million acres.

The yellow-flowered alfalfas imported at the turn of the century, the concept of alfalfa as a range legume expressed in 1913 and the alfalfa breeding program inaugurated in 1947 resulted in the creation of the second and third pasture-type alfalfa varieties ever developed.

The alfalfas were interseeded on native pasture and range. They increased forage production, improved forage quality and raised the carrying capacity of hundreds of thousands of acres grazing lands.

CHAPTER XXIV FORAGE GRASSES

J. G. Ross

Almost the whole of South Dakota was a vast grassland prior to settlement, but the early settlers found that these native grasses did not adapt well as domestic grasses because seed could not be readily obtained, and stands were difficult to produce from the scanty seed that could be laborously harvested. It is not surprising then that some of the first evaluations of crops at the new South Dakota Experiment Station included forage grasses.

PERSONNEL

Grasses, like other crops, were handled by botanists until 1908. After that date, they became the responsibility of agriculturists and agronomists. Though they were included in 5- and 6-year rotations, at the substations, little else was done, except for some species evaluation tests conducted by C. J. Franzke in the 1930s, until after World War II. Staff members who worked with forage legumes also worked with grasses until September 1947. At that time J. G. Ross was hired to work full-time with grasses. He supervised the work of eight graduate students who worked with grasses.

James B. Weber	M.S.	** -1972
E. K. Marion	M.S.	1970-1972
Ronald T. Thaden	M.S.	11/1/69-7/1/73
Delmer F. Gross	Ph.D.	1971-1974
George L. Holborn	M.S.	1973-1977
Ping Fai Lo	Ph.D.	1976-1979
Arvid A. Boe	Ph.D.	1976-1979
Terry Heilman	M.S.	1977-1980

SPECIES EVALUATIONS

The original 1888 fieldbook in which the first experiments were recorded has been preserved and is a record of the difficulties experienced in establishing these first introduced grasses at Brookings. This notebook was headed "Experimental Field No. 1. Comprising 66 plots of Grasses and Grains." Each plot contained 1/8 acre. Notes were taken by John M. Aldrich, Assistant Entomologist, and Alvah George Cross, senior student from Yankton, associate editor of the "Collegian". They left meticulous notes on the performance of the grasses and legumes planted on April 30, 1888, in "a light snow about 2 inches deep." Kentucky bluegrass came "first above ground" on May 21 and on April 30, 1889, was a "thin stand covering 1/10 of ground, about 4 inches high and healthy." Orchardgrass, red top, timothy, meadow foxtail and fescues, to mention just a few, were also tried. In all, 22

species and varieties of grasses and legumes were tested.

Smooth brome grass was introduced into the United States from Hungary in 1884 and was tested at Brookings in 1890. Many different native and introduced grasses and legumes were evaluated and analyzed chemically by James H. Shephard in 1894 to obtain an indication of their possible forage potential. These tabulated compositions, however, could have contributed very little to the livestock feeding management of that time, but it was one of the first efforts to relate forage quality to genotype of the grasses and heralded the forage quality work pursued in modern grass breeding.

In 1894 smooth brome grass was indicated as the best of all the introduced grasses that had been tested up to that time. In an 1896 field book it was noted of this grass that the "catch, stand and hardiness were all that could be desired."

Seed of this species must have been available at that time because Thomas A. Williams wrote in 1895 that seed could then be obtained from the "most highly recommended seed companies." Seed of the grass must have spread rapidly because this was just 11 years after its introduction into the country. He reported that smooth brome grass had produced a paying crop every year for 5 years and rated it above Timothy, red fescue, hard fescue, sheep's fescue and red, white and alsike clovers (Bul 45). Williams left South Dakota in 1896 to join the Division of Agrostology of the USDA. His successor was DeAlton Saunders.

In 1897 J. H. Shephard and E. C. Chillicott described experiments under irrigation at Mellette, 20 miles north of Redfield. A total of 36 grasses and clovers were planted on 1/4-acre plots on the Hunter-Salzer Farm by Williams or Chilcott. They included smooth brome grass, several fescues, redtop, Kentucky bluegrass, timothy, orchardgrass, several ryegrasses and some grass mixtures. In addition, square-rod plots were seeded to 70 varieties of grasses and clovers for more precise comparisons (Bul 59).

Among the mixtures tested, smooth brome grass and alfalfa was found to be superior. The total weight of dry hay from three cuttings was 10,800 lbs. This mixture was considered so outstanding that it was given the name "Bromusal" and was recommended as the highest producing forage mixture under irrigation (Bul 59).

During the 1890s disastrous droughts in the central part of South Dakota created a concern that the forage supply be stabilized to a greater degree. Accordingly, the Highmore Substation was established to determine "drought resistant forage crops" for the region.

In 1899 Saunders planted 50 1/4-acre plots to crops that might either be used for grazing or as harvested forage. He planted smooth brome grass, short-awned brome grass, Nevada bluegrass, King's fescue, woodland ryegrass, giant ryegrass, slender wheatgrass and western wheatgrass from Wyoming and slender wheatgrass, bluegrama and silvery saltbushes from Montana, that had been collected in 1898 by Williams and Griffiths. Other perennials included smooth brome grass, which was produced at Brookings, wild timothy, Canadian bluegrass, green needlegrass and false couchgrass (Bul 66). Saunders and L. W. Carter planted an additional 12 varieties of perennials and 15 annuals in 1900. They included several species of brome grass, Washington bluegrass, French and Smarkand alfalfa, sweetclover sand and bitter vetch (Bul 70).

In 1902 they concluded that Nevada bluegrass, feather bunchgrass (green needlegrass), western wheatgrass and brome grass gave promise of being useful for range renewal. Under dryland conditions the merits of both smooth brome grass, alone and in mixture with alfalfa, were recognized and recommended to ranchers and farmers. The superiority of annual sorghum forage for winter feed and its value in stabilizing feed production during drought periods was demonstrated (Bul 74). This type of forage crop evaluation continued until Saunders left the Experiment Station in October 1903. He was succeeded by W. A. Wheeler, another botanist.

Early 1900s

In 1904 Wheeler and Sylvester Balz planted a large number of square-rod plots of grasses, clovers and alfalfa at Highmore. They decided that the quality of barnyard millet (barnyard grass) was too low and that pearl millets were too late in maturity for Highmore. They also observed that proso millets were early maturing (75-85 days) and drought-resistant. They were considered to be grain producers. Fox-tail millets were later maturing (85-110 days), leafier, and much better for forage, but not as drought resistant (Bul 96).

Though some of the forage crop development work continued, it appears that most of the plots were destroyed at Highmore in 1908. Clifford Willis, Chief in Agronomy and Superintendent of Substations, revised the plot arrangement and installed 34 crop rotations.

Only two 1-acre blocks were left for grasses. He installed similar rotations at the new substations at Eureka in 1908 and Cottonwood in 1909. At each location alfalfas, sweet-clover and smooth brome grass were included in the rotations. All three crops were seeded by different planting methods.

Work with the various species of forage grasses was continued throughout the next few decades but emphasis during this period was mainly on food crops. In a field book used by Mathew Fowlds in 1915 and 1916 were notes on 49 grasses such as timothy, meadow foxtail, redtop, tall oatgrass, orchardgrass, fescues, smooth brome grass, slender wheatgrass and western wheatgrass that were grown for observation. This evaluation work contributed to the spread of these species into the various areas where they were adapted in South Dakota.

In these early years there was no established procedure for varieties or excellent plant material to be released to the farmers. Therefore, research workers sent packets of material to any interested individuals in hopes that the material would become established and contribute to the economy.

1930-1950

During the drought years of the 1930s there was a great interest in establishment methods and species of grasses that could be used in reestablishing the grasslands that had been destroyed or abandoned croplands that needed to be regressed. C. J. Franzke and A. N. Hume studied the various factors necessary to establish grasses, including the most adapted species in different parts of South Dakota, and also depth and rates of seeding.

From 1936 to 1939 C. J. Franzke, in cooperation with several Soil Conservation Districts, planted grass adaptation trials at Vermillion, to represent the area with over 24 inches of average annual rainfall; at Brookings and Helca for the 20- to 24-inch rainfall area; at Highmore for the 18- to 20-inch area; and at Cottonwood, Winner, Pine Ridge and the U.S. Dryland Experiment Station at Ardmore for West River (Bul 361).

Warm-season grasses best adapted to Southeast South Dakota were big bluestem, switchgrass and grama grasses. The best cool-season grasses for this area were Kentucky bluegrass, reed canarygrass, smooth brome grass and intermediate wheatgrass. The best grasses for the 20- to 24-inch rainfall area were brome grass, crested, western, intermediate and slender wheatgrasses, switchgrass, side oats grama and green needlegrass.

For the Highmore area, crested wheatgrass

was the best followed in order by western wheatgrass, Russian wildrye and green needlegrass. The grasses best adapted for the West River area were western wheatgrass, green needlegrass, crested wheatgrass, Russian wildrye, side-oats grama, blue grama and buffalo-grass (Bul 361).

Of South Dakota's 49 million acres, 29 million were classed as grassland in 1942. Grassland covered 80% of West River, 50% of the 14 counties just east of the river and 35% of the eastern counties (Bul 361).

J. G. Ross took charge of grass investigations in 1947. He planted eight grasses on irrigated and non-irrigated land on the Huron Development Farm in the spring of 1949. Nine grasses were planted under irrigation in spring and fall of 1950. Under irrigation, average hay yields in 1951 and 1952 ranged from 1.15 to 1.65 tons per acre. The 1952 seed yields ranged from 210 to 366 pounds per acre. Smooth brome grass and Ree wheatgrass were the best hay producers and poorest seed producers while the reverse was true for crested wheatgrass (Cir 107).

Several rates of nitrogen fertilizer were applied to the 1950 seedlings in 1951 and 1952. When 40 pounds of nitrogen per acre were applied, seed yield was 250% higher for smooth brome grass and Ree wheatgrass, 200% higher for tall wheatgrass and 400% higher for crested wheatgrass. When the fertilizer rate was doubled, seed yields increased 325%, 305%, 250% and 480% for the same grasses. Hay yields were increased by nitrogen application, but they were no higher than the yields of an alfalfa-grass mixture (Cir 107).

1950-1980

In 1953 approximately 43 million acres provided revenue from agriculture. About 14.6 million acres were in row crops and small grain, 1.2 million in tame grasses and legumes and 27.2 million acres in native grasses. It was suggested that acreages be reduced to 13.6 million for row crops and small grains and to 23.7 million for native grass. It was also suggested that 5.9 million acres be devoted to tame grasses and legumes, and the acreage of perennial crops be increased from 28.4 million to 29.6 million acres (Bul 427).

J. G. Ross summarized 27 years of grass species and variety performance testing in 1976. At six locations, the highest yielding species were intermediate wheatgrass, smooth brome grass and crested wheatgrass in that order. Crested wheatgrass produced more forage than brome grass at Cottonwood. Western wheatgrass yielded about the same as crested wheatgrass and smooth brome grass in central

and western portions of the state. Orchard-grass frequently winter killed. Reed canary-grass and creeping foxtail were adapted to wet areas and tall wheatgrass to saline areas.

The most productive varieties were Achenback, Lincoln, Sac and Saratoga smooth brome grass; Oahe and Chief intermediate wheatgrass; Nordan crested wheatgrass; Vinall Russian wild rye; Lodorm and Green Stipa green needlegrass; Garrison creeping foxtail; Alkar and Largo tall wheatgrass; and Ioreed and Frontier reed canarygrass.

GRASS BREEDING

Shortly after W. A. Wheeler took charge of forage investigations at Highmore he initiated a program in plant breeding. In 1905 seed from different sources was planted in hills with equidistant spacing of 44 inches. After emergence, plants were thinned to leave one plant per hill for observation (Bul 96). Records in a 1906 field book indicate that smooth brome grass was handled in this manner.

Also, a grass nursery was started at Highmore in the spring of 1905. Rows were planted to seed from over 100 collections made in Western South Dakota, during 1904 by W. A. Wheeler (Bul 96).

Breeding work with slender wheatgrass and western wheatgrass was also undertaken in conjunction with extensive testing and observations of various introduced species of grasses to determine their adaptation. This was the first actual grass breeding involving selection and evaluation of individual plants in South Dakota for which records can be found. The value of these various forage crops for this area was demonstrated and farmer acceptance of the species and strains was influenced by the work at Highmore.

Ree Wheatgrass

Ree intermediate wheatgrass was introduced by the USDA from Leningrad, Russia, in 1932. C. J. Franzke obtained seed from the Soil Conservation Service in the fall of 1937 and planted it in a wheatgrass nursery at Brookings and at several locations in the plantings made cooperatively with the SCS. It had large seeds, was easily established, and yieldwise was superior to the other wheatgrasses. He increased the seed and released it as a variety in 1945 (Bul 58).

Most grass varieties were developed for a special purpose. Plants with the desirable characteristics were obtained by mass selection. They were then planted in a nursery where they could cross pollinate with one another. Seed from all plants was harvested

and bulked. It became the seed of the new variety.

Homesteader Bromegrass

Franzke or Erickson collected seed from several farmer fields of smooth bromegrass that had been growing 40 years or more. Plants from this seed were growing under test when Ross arrived at SDSC. He selected five of the plants and used them to produce the synthetic variety, Homesteader, that was released in 1951. It provided a source of adapted forage seed during the 1950s.

Oahe Intermediate Wheatgrass

Oahe intermediate wheatgrass was developed to obtain a high seed yielding variety. Ross selected high seed producing plants in a nursery of self- and open-pollinated progenies of Ree wheatgrass. After two generations of polycross testing and selection for high seed set, forage yield and rust resistance, four clones were chosen. They were planted together and allowed to cross pollinate. The bulk seed from the four clones became breeder's seed for the synthetic variety that was released in 1962 (Bul 506). Oahe had large seeds and both high forage and seed production. A seed production area was established in South Central South Dakota, particularly around Wagner. It is estimated that at least \$200,000 worth of seed was exported annually from the state for several years.

Summer Switchgrass

Summer switchgrass, a warm-season variety, was developed to provide a supplemental pasture for a bromegrass-alfalfa pasture. The bromegrass-alfalfa combination was unequalled for spring and fall grazing, but the cool-season bromegrass was somewhat dormant during July and August. Materials from collections of switchgrass were supplied by Dr. L. C. Newell from the University of Nebraska for evaluation at Brookings. Ross selected plants from a collection made near Nebraska City because of their high forage and seed production. They were used to produce a synthetic variety that was released in 1963. Summer did much to promote the concept of long season tame pasture. Higher gains of beef per acre were obtained by rotating adapted varieties of species physiologically adapted to each part of the growing season--cool-season species during cool weather and a warm-season grass in warm weather.

Rebound Bromegrass

Another way of meeting the need for a more productive grass in mid-summer was to develop a strain of the normally cool-season smooth

bromegrass that grew during the summer when bromegrass normally became dormant. A space-planted nursery was established during the fall of 1970. It included 5,623 plants of South Dakota 7 and 29,039 plants of Saratoga, a New York cultivar released for its regrowth characteristics. They were compared with creeping foxtail, reed canarygrass and orchardgrass. In 1971 smooth bromegrass plants that showed good regrowth after cutting were selected and evaluated for photosynthetic rate and for regrowth in the greenhouse.

Thirty-two genotypes were selected and planted in replicated 2- by 10-foot vegetative plots. They were harvested twice during the first season and four times during the second, and they were evaluated for forage and seed yield as well as for regrowth capabilities.

Four genotypes from Saratoga were selected and placed in isolation to produce synthetic seed which was tested in forage experiments at Brookings, Redfield and Rapid City. The 4-clone synthetic was designated as a pasture variety and named Rebound for its excellent ability to produce regrowth after being harvested. It was released in 1978. Hopefully, it will produce forage for grazing during the hot summer months when most bromegrass varieties are generally somewhat dormant.

Cottonwood Bromegrass

During the 1970s it appeared that a grass adapted to the 14-inch rainfall area would be needed to reseed the 1.25 million acres of rangeland that had been plowed in 1973 and 1974 after acreage controls of the Wheat Stabilization program were removed. Ross and Holborn collected materials of smooth bromegrass from five patches that were growing on the hillsides of the Cottonwood Field Station. The materials were planted in a nursery at Brookings and allowed to cross pollinate. Seed harvested from the most desirable plant was increased and released in 1979 as the variety Cottonwood.

Other Varieties

Creeping foxtail was adapted for use as a forage crop in wetlands that flooded in the spring. Garrison, the best variety, had a tendency to "shatter" and drop its seeds before harvest. Selections were made for vigor and seed retention. The best five plants were made into the synthetic variety, Retain, that was released in 1979.

The greatest drawback to the use of warm-season grasses is the difficulty of establishment so the grass could be utilized the second year after seeding. Large-seeded strains of

switchgrass and big bluestem are now being evaluated for possible release.

GRASS VARIETIES DEVELOPED IN SOUTH DAKOTA

<u>Variety</u>	<u>Crop</u>	<u>Year of Release</u>
Ree	intermediate wheatgrass	1945
Homesteader	smooth brome	1951
Oahe	intermediate wheatgrass	1962
Summer	switchgrass	1963
Rebound	smooth brome	1978
Cottonwood	smooth brome	1979
Retain	creeping foxtail	1979

Oahe intermediate wheat grass, Summer switchgrass and Teton and Travois alfalfa revolutionized the pasture improvement and management programs in the state.

A mixture of Oahe and either Teton or Travois with a good variety of smooth brome provided the most productive cool-season pasture ever used in South Dakota. Summer provided the most highly productive perennial warm-season pasture. By grazing cool-season and warm-season pastures rotationally, a high level of production was maintained over a 6-month period.

The development of Rebound smooth brome, which is less dormant during hot weather than other brome species, may make it possible to use one tame pasture that is highly productive all the grazing season. Also, the development of Cottonwood brome may make it possible to have highly productive tame pastures in the areas generally devoted to range.

MAKING HAY IN THE 1920s



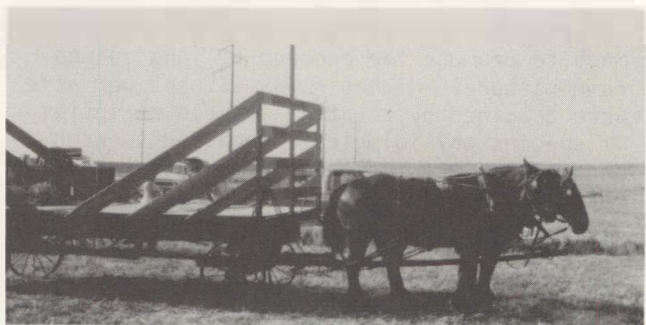
Hay rake used to rake mowed hay into windrows and "bunch" the windrows.



Buck rake used to move hay from windrow to hay stacker.



Over shot hay stacker.



Hay rack used to haul hay from stack to feeding area.

CHAPTER XXV PASTURES

Prior to 1900 native grasses were the principal, and in many instances, the only feed used for all livestock production. However, in the older more settled areas, the native grasses were fast disappearing and being replaced by inferior introduced grass such as bluegrass, fescue and worthless weeds. The primary causes were overstocking and trampling (Bul 81).

Overstocking was difficult to avoid. If enough stock were kept to utilize feed during flush periods of growth, they overgrazed the pasture during less productive periods. On the other hand, if only enough livestock were kept to properly stock the pasture during dry weather, the grass made such rank growth during more favorable growing periods that it was unpalatable and livestock did not graze it during dry periods (Bul 81).

In 1903 E. C. Chilcott reported that undesirable weeds and grasses had been removed from the low lying college pastures by grazing sheep with the cattle and horses during 1900-1902. He suggested that five or six head of sheep for each cow be used to renovate weedy pastures and that the number of sheep be reduced after the weeds had been exterminated (Bul 81).

PASTURE RESEARCH

The first pasture research was conducted by an agriculturist. Animal Husbandmen grazed alfalfa in 1912 and dairymen tested several annual or biennial crops in the 1930s and 1960s. Agronomists became involved in pasture research in 1948.

Smooth brome grass had been grown at the Experiment Station since 1890. During the early years it was used exclusively for meadow and seed but, starting in 1900, Chilcott tested it as a pasture grass. By 1903 it had proven to be the best grass yet tested for that purpose.

Smooth brome grass started early in the spring (6 to 8 inches tall by May 11), made a tough sod, was not easily killed by close grazing or trampling, competed strongly with weeds and inferior grasses, remained green late in the fall, and was greedily eaten by all kinds of stock. It produced well on both upland and bottom land but became turf-bound the third or fourth year after sowing. It was believed that it would be desirable to either "break it" up or use it for pasture after cutting three or four crops of seed or hay (Bul 81).

By 1903 it was believed that alfalfa could be successfully grown in nearly all parts of the state, east of the Missouri River, and some areas west of the River, but it was not adapted to higher uplands underlain with hard, clayey subsoils. E. C. Chilcott suggested alfalfa could be used as a pasture or soiling (now called green chop) crop (Bul 81).

ANIMAL HUSBANDRY RESEARCH

During the early summer of 1912, J. W. Wilson started experiments in which yellow-flowered alfalfa was used as pasture for cattle and sheep and a soiling crop for swine. Alfalfa hay was palatable to sheep and they preferred it to sweetclover for pasture. Hogs fed a soiling crop and corn gained 28 more pounds in 41 days with alfalfa than with brome grass as the soiling crop (Bul 141).

In 1940 the State Land Use Planning Committee requested that the Experiment Station assemble grazing capacity information for the state. The Animal Husbandry Department, in cooperation with the Soil Conservation Service, conducted surveys in 1940 through 1942 and in 1946 (Cir 70).

In 1946 there were 28 million acres of grassland in South Dakota. The state was divided into 19 range and pastures areas that fell into four natural areas in which recommended grazing management and treatment practices were similar (Cir 70).

The eastern area included a strip about 60 miles wide along the eastern edge of the state. The most desirable species included the native tall grasses--big bluestem, switchgrass, porcupine grass and green needlegrass, native mid-grasses--little bluestem, sideoats grama, needle and thread, and western wheatgrass, and introduced species--crested wheatgrass, smooth brome grass, Kentucky bluegrass, reed canarygrass and alfalfa.

An east central area included the remainder of the East River area. Alfalfa, bluegrass, and reed canarygrass were not included in this area and smooth brome grass was not included for counties bordering the Missouri River. The tall grasses were more important than mid-grasses in eastern counties of the area while the reverse was true in western counties (Cir 70).

All the West River area except the Black Hills region was included in a third set of management recommendations. Crested wheatgrass was the only introduced species included. Though tall grasses were desirable,

they became increasing less important moving from east to west. Likewise mid-grasses were more important in eastern counties than in western counties of the area, while the reverse was true for shortgrasses bluegrama and buffalo grass.

Recommendations for the Black Hills area included smooth brome grass, timothy, Kentucky bluegrass and more tall and mid-grasses; but no short grasses (Cir 70).

For 30 years the Animal Husbandry (now Animal Science) Department conducted extensive Range Management Studies at the Range Field Station near Cottonwood, the Antelope Range Field Station in Harding County, and other locations. Enough data were collected to fill a book. No attempt has been made to summarize it here.

DAIRY RESEARCH

During the 1920s Manley Champlin noted that dairy cattle walked across the yellow- and white-blossomed sweetclover pastures on the Vivian Substation to graze alfalfa. They sometimes passed up the alfalfa to graze native grass (Bul 253).

From 1927 to 1931 T. M. Olson and B. L. Robinson, of the Dairy Department, compared alfalfa, sweetclover, and sudangrass for pasture for dairy cows. They concluded that dairy production per day was highest on sudangrass during July and August, but that total production was higher from alfalfa and still slightly higher from sweetclover. Total TDN and net profit were highest from sweetclover, followed by alfalfa and sudangrass (Bul 265).

The experiment continued until 1937. Results obtained the first 3 years were confirmed and other information obtained. Both the legumes caused bloating; cows liked sudangrass the best and sweetclover was the least palatable; average number of grazing days was 67 for each legume and 51 for sudangrass (Bul 324).

During the 1960s and 1970s Howard Voelker of the Dairy Department conducted several grazing studies at Brookings.

Dairy cows were grazed on Piper sudangrass, a sudan hybrid and a sorghum-sudan hybrid. Each provided 109.5 cow days of grazing. Milk production was similar from Piper sudan and the sudan hybrid and slightly higher than from the sorghum-sudan hybrid. The cattle consumed two thirds of the forage from Piper sudan, over half of the sudan hybrid and less than half of the sorghum-sudan hybrid, indicating that Piper was most palatable (Farm & Home Research, 1968).

Dairy yearlings grazed on the same three types of pastures planted in 6-, 12- and 36-inch rows. Narrow rows produced the most forage and had less weed competition but there was less trampling in the wide rows. The highest yields of dry matter for the three pastures were obtained from the sudan hybrid in 12-inch rows. Highest yields for the sorghum-sudan hybrid and Piper came from 6-inch rows but they were only 75% to 80% as high as for the sudan hybrid in wider rows (Farm & Home Quarterly, 1968).

Soybean-sudangrass pastures were grazed from June 25 to September 16. The pasture was divided into five parts and 10 cows per acre were rotated daily. Pasture produced 5,073 pounds of milk for a net profit of \$77.00 per acre. The same crop used as hay produced 3,672 pounds of milk and a net profit of \$17.85.

Voelker and C. R. Krueger grazed Summer switchgrass and a sorghum-sudan hybrid with dairy cattle at Brookings for 2 years. During the first year each pasture produced 93 cow days of grazing per acre, but, switchgrass only produced 52 cow days and the sorghum-sudan hybrid 67 cow days of grazing in the second year. Cows on sorghum-sudan produced 10% more milk per acre the first year and 25% more the second, than those that grazed switchgrass.

PASTURE RECOMMENDATIONS

Several pasture mixtures were recommended for various areas of the state in 1950 and 1953. Recommendations were based primarily on forage yields of several grass species at Brookings and the three substations at Highmore, Eureka and Cottonwood. Results indicated which species were most productive in the various areas.

Pasture mixtures recommended in 1950 for the East River area included grasses and legumes. Two or more adapted species gave higher yields than one species grown alone. Grasses in the mixture gave better erosion control, improved soil structure, and reduced the chance of bloat. Legumes provided nitrogen for the grasses and produced forage with higher protein content (Cir 81).

The recommended mixture for the Black Hills region and the eastern two tiers of counties included smooth brome grass, Ree wheatgrass and alfalfa or sweetclover. An alternative mixture included timothy, red clover and a small amount of white clover.

The primary mixture was the same for the James River area but crested wheatgrass and alfalfa or sweetclover were included in an alternate mixture.

For the two tiers of counties east of the Missouri River Ree wheatgrass and alfalfa or sweetclover were recommended in Mixture A. Smooth brome grass replaced the wheatgrass in Mixture B and crested wheatgrass replaced it in mixture C (Cir 81).

Mixture C was suggested as mixture A for West River in 1953 and Western wheatgrass was added to the mixture as an alternative (Bul 427).

AGRONOMIC RESEARCH

Starting in 1948 grazing studies, using beef cattle on introduced grass and legume species, were conducted jointly by the Agronomy (now Plant Science) and Animal Husbandry (now Animal Science) Departments. Though an agronomist was the project leader, most decisions concerning the cattle were made by an animal husbandman.

Agronomy Personnel

Staff Members

Dr. W. W. Worzella*	1951-1958
Dr. R. A. Moore*	1959-1969
Dr. C. R. Krueger*	1970-1973
Dr. J. E. Green*	1974-1976
Dr. F. R. Vigil*	1977-
Glenn Embry	1977-1978

Graduate Students

Laurel Howe	M.S.	1962-1963
Donald T. Winch	M.S.	1965-1967
Loren Romann	Ph.D.	1967-1970
Roger Wickstrom	M.S.	1967-1969
C. M. Smith	Ph.D.	1968-1971
Richard A. Lockert	M.S.	7/69-1972 (1974)
Lloyd H. Hansen	M.S.	1969-1972
Levi Akunbaweni	M.S.	1978-1980
Steve Fransen	Ph.D.	1978-

*Project leader.

Huron Development Farm

The first pasture research involving beef production was conducted on the Huron Development Farm from 1948 to 1952. Seven different pastures were grazed with high grade yearling Hereford steers and heifers. They included native pasture, fertilized native, and alfalfa-brome on dry land; and brome-Ree wheatgrass, alfalfa-brome, alfalfa-Ree-brome and a mixture of several grasses and clovers under irrigation. Beef gains for the seven pastures ranged from 94.8 to 357.5 pounds per acre. These gains, however, did not reflect the death loss from bloat on the alfalfa-Ree-brome pasture in 1952 and from the mixture

of alfalfa and several grasses and clovers in 1951 and 1952 (Cir 107).

Brookings and Newell

Two 5-year experiments were conducted on the east 40 acres of the "Olson Eighty" across the road from the Agronomy Farm. A 3-year study with irrigated pasture was conducted on the Newell Field Station.

The first Brookings study, by W. W. Worzella, was conducted from 1951 to 1955. Yearling Hereford steers were grazed on (1) fertilized brome grass, (2) alfalfa-brome grass, (3) soybean-sudangrass, and (4) winter rye-sweet clover.

One animal was lost from bloat during the first year of grazing on the alfalfa-brome-grass mixture. This pasture annually produced an average of 308 pounds of beef per acre for 5 years while the fertilized brome grass pasture produced only 236 pounds. Over a 4-year period the soybean-sudan pasture produced an average of 147 pounds of beef from 1.28 tons of forage per acre (Farm and Home Quarterly, 1958).

Five years later, from 1956 to 1960, smooth brome grass and Ree wheatgrass were each mixed with Teton alfalfa and grazed with yearling Hereford steers. Each pasture was divided into two equal parts and rotationally grazed. One-half of the pasture was grazed four times and the other half, three times. Cattle were removed from the pasture in September. The smooth brome grass-alfalfa pasture produced an average of 194 pounds of animal gain and 0.85 ton of hay per acre over the 5-year period. The intermediate wheat-grass-alfalfa pasture averaged 209 pounds of animal gain and 0.83 tons of hay. There were no losses from bloat. These pastures provided 1 animal unit month of grazing for 4.5 months or 4.5 animal unit months of grazing.

At Newell J. R. Johnson grazed two irrigated pastures from 1965 to 1967. The smooth brome grass-orchardgrass-alfalfa pasture produced an average of 334 pounds of beef per acre over the 3-year period while the grass without alfalfa produced 275 pounds of gain (Farm and Home Quarterly, 1968).

The value of alfalfa depended on the price of beef. If beef were worth \$30 per hundred pounds, the alfalfa increased net income by \$28.85 per acre at Brookings and \$39.70 at Newell.

Since these trials indicated that 60 to 70 pounds of beef per acre could be raised if alfalfa were included in the mixture, it meant that an operator could afford to annually lose

from bloat or other causes a 900- to 1000-pound animal on every 15 acres without actually losing money. If he did not lose an animal on each 15 acres each year then the alfalfa increased his net income.

PASTURE RESEARCH CENTER

The Pasture Research Center was located near Norbeck in Faulk County. The farmstead was 10 miles north, 3 miles west and 1/2 mile north of the city of Faulk on the SE 1/4 of Sec 19, T 120 N, R 69 W. The 2665-acre ranch was leased from Curtis Wik in 1965 for a period of 10 years for \$4.70 per acre. The lease was renewed for a 5-year period in 1975 for \$10.00 per acre and again in 1980 for \$12.50 an acre.



Northwest view of Pasture Research Center.

Station Personnel

Four men have served as Superintendent of the Center.

Gary Haywick	6/1965-1/1970
James E. Olson	1/1970-1/1971
Dale Curtis	1/1972-6/1979
Don Huber	7/1979-

History of the Pasture Research Center R. A. Moore

The Pasture Research Center was established in 1965 to provide opportunities for studying ways of improving pasture and forage production. Although it was anticipated that much of the results would be useful statewide, a site was selected that was more typical of about a 20-county area in Central South Dakota.

Several farms and ranches were looked at before deciding on the Wik property in Faulk County, near Norbeck. This unit consisted of about half rangeland and half cropland. Approximately 400 acres were initially kept for crop production and the net returns were compared with those from pasture and forage crops. In recent years much of the 400 acres has been used for additional pasture evaluations.



R.A. Moore & B. Haiwick at Pasture Research Center.

In 1965 a \$90,000 federal grant was received to study "The Efficiency of Beef Cattle Production in South Dakota With Various Methods of Land Use and Cattle Management." This provided the means for the establishment of the center.

Three hundred uniform Hereford heifers were purchased from one herd and this group became the basis for the cow-calf operation used to evaluate native pastures, short-season tame pastures, and a full-season tame pasture series. The cows were wintered at two levels of nutrition and kept on the same winter level and summer pastures during the entire length of the 10-year study.

Researchers were interested in the effect on the reproductive performance of the cows as indicated by number of calves, weights of calves, and total beef produced per acre. It was a cooperative project with Plant Science, Ag Engineering, Animal Science, Economics and Horticulture and served as a field laboratory for many students.

The experiments were designed to determine the most efficient system of sustained land use for the production of beef cattle. Though most of the ranch was used for grazing trials, several hundred acres were devoted to the production of corn and alfalfa to provide silage and hay for the cattle herd during the winter. Half of the cows from each of three pasture systems were fed on a maintenance ration when not on pasture and the other half on a below maintenance ration calculated to let them lose 100 to 200 pounds of weight during the winter. Animal scientists took blood samples and kept other records needed to evaluate the differences between the rations. Economists also used

production records for use in calculating costs and returns.

Pasture Systems

Three pasture systems were tested: (1) native pasture, (2) short-season tame pasture, and (3) a full-season tame pasture series. All tame grass pastures were established in April 1965, except for switchgrass which was planted in June 1968.

System 1 was native grass that was considered to be in fair to good condition and consisted mainly of Kentucky bluegrass, western wheatgrass, bluegrama, and green needlegrass. Sixteen cow-calf pairs grazed in each of the eight 96-acre pastures (four pastures for each wintering ration).

System 2 was a short-season pasture that contained Auchenbach smooth bromegrass, Oahe intermediate wheatgrass, and Teton alfalfa (BIA). Each of eight 32-acre pastures was grazed by ten cow-calf pairs.



Hereford cows on BIA pasture.

The full season series pasture system included four pasture mixtures. Nordan crested wheatgrass was seeded in 8-acre pastures for grazing in early spring. The same BIA mixture used in the short-season pasture was seeded in 12-acre paddocks for use in late May and June and again in August and September. Piper sudangrass was seeded in 6-acre pastures for grazing between July 10 and August 20. After 2 years, Summer switchgrass was used to replace the sudangrass. Vinall Russian wildrye was seeded in 8-acre paddocks for grazing after mid-September. The 34 acres provided pasturage for 10 cow-calf pairs except that only 6 pairs grazed the switchgrass.

As the grazing season progressed the stocking rate was adjusted with the "put and take" system so as to utilize all the forage without overgrazing the pastures.

A uniform group of 300 Hereford heifer calves was purchased in November 1965 and bred to calve as 2-year olds in the spring of 1967. They were bred by artificial insemination, and closely related clean-up bulls were used to maintain uniformity in offspring and reduce genetic variability.

Grazing experiments began in 1967 and ended in 1974. Though the grazing season varied somewhat from year to year the average season was May 17 to November 5 for native grass, May 25 to October 2 for the short-season pasture, and April 22 to November 2 for the long-season series of pastures. Average grazing seasons for the various pastures in the series in system 3 were April 22 to June 2 for crested wheatgrass, June 3 to July 14 and August 20 to September 19 for the BIA, July 15 to August 19 for switchgrass, and September 20 to November 2 for Russian wildrye.

Native grass in System 1 provided 0.96 animal unit-months per acre (AUM/A) of grazing in 172 days. Calves gained 1.58 pounds per day for a total of 272 pounds per calf. With an 85% calf crop this was 38.8 pounds of gain per acre.

BIA in System 2 provided 1.33 AUM/A of grazing in 130 days. Calves gained 1.69 pounds per day for a total of 220 pounds per calf and 60.1 pounds per acre.

The series of several grass species in System 3 provided 1.74 AUM/A of grazing in 194 days. Calves gained 1.61 pounds per day for a total of 312 pounds per calf and 64.5 pounds per acre.

The BIA, grazed intensively during the 3 periods of maximum growth, in System 3 provided 1.99 AUM/A of grazing for 73 days which was about 50% higher than the same pasture grazed less intensively over a longer period in System 2.

Also a combination of BIA and switchgrass, in System 3, produced 3.92 AUM/A of grazing during 109 days which was almost three times as high as obtained from BIA alone in System 2.

The most AUM/A, highest total gains, best gains per acre, and second best gains per day were obtained from the series of tame pastures in System 3. Though animal production was best on System 3, costs of production were also the highest.

With a 92% calf crop the best returns were obtained with a short-season tame pasture and a long season of hay in the drylot. With only 85% calf crop best returns were obtained from native pastures, emphasizing the importance of good cow management especially on high priced pastures. Regardless of management, however, the series of tame pastures did not appear to be economically feasible, primarily because of the cost of fertilizer required for pastures that did not include alfalfa in the mixture.

Warm-Season Pastures

Frequently warm-season grasses such as little bluestem and sideoats grama were dominant on steep slopes and on weakly developed South Dakota soils. Big bluestem, switchgrass, and Indiangrass were warm-season grasses that were dominant on deep soils with favorable moisture in high range conditions in Eastern South Dakota. These grasses made excellent mid-summer pastures.

Several warm-season grasses were grazed with yearling steers from 1971 to 1973. Pawnee big bluestem produced the most days of grazing followed by Nebraska 28 and Summer switchgrass, Pierre sideoats grama, and Holt yellow Indiangrass. Indiangrass, on the other hand, was the most nutritious. Steers grazing it gained 2.4 pounds per day compared to 2.0 for the switchgrasses and sideoats grama, and 1.5 for big bluestem. Steers on switchgrass produced slightly more pounds of beef (1.28) per acre than big bluestem, and about 25% more than Indiangrass and the midtall sideoats grama.

Growing and Finishing Steers

In 1975 an additional federal grant of \$146,000 provided an opportunity to change directions in the major research effort and to continue the center for another 5 years.

F. R. Vigil

The objectives of a study conducted from 1977 to 1979 were to develop the most efficient system of using pasture for beef cattle production. Hereford steers grazed on (1) native range (2) native range interseeded with Travois alfalfa and (3) a series of seasonal tame pastures of crested wheatgrass, bromegrass-alfalfa, sudangrass, and Russian wild-rye. Pastures were supplemented with three levels of energy--corn at 0, 0.05 and 1.0% of body weight each day.

Over the 3-year period pasture systems 2 and 3 produced 50% more (about 45 pounds) beef per acre. Average daily gain was increased 18 and 25% by the two levels of energy supplementation.

Interseeding

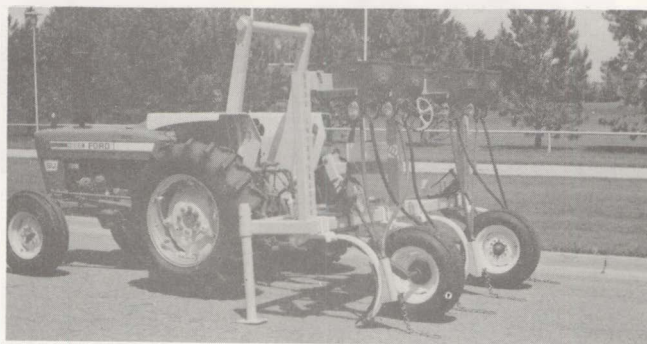
During the 1960s M. D. Rumbaugh and R. A. Moore conducted numerous result demonstrations on improvement of range or pasture by interseeding with alfalfa or an alfalfa-grass mixture. They built special interseeding equipment that cut small furrows in the sod and planted the seed in the bottom of the furrows. Alfalfa provided nitrogen for the grasses and forage yields were increased.

J. E. Greene used an interseeder built by the Agricultural Engineering Department around 1970 to interseed three 100-acre pastures on the Pasture Research Center in 1975. They were used for the beef production studies conducted by Vigil.



Pasture interseeder built in 1970.

F. R. Vigil and T. S. Chisholm of the Agricultural Engineering Department built another machine in 1979.



Pasture interseeder built in 1979.

POTENTIALS FOR INTERSEEDING F. R. Vigil

South Dakota calculations, based on pasture research studies, estimate that if 8% of the state's range and pastureland (15% east and 5% west of the Missouri River--2 million acres) would be improved through interseeding, the potential benefit to the state, through increased beef production, would approximate 20 million dollars per year.

Although interseeding offers a tremendous potential for increasing pasture and rangeland productivity, the practice has not progressed as fast as it could. An important consideration in this delay has been the lack of a suitable drill for use in semi-arid environments. The drill has to operate under adverse site conditions (rocky, heavy soils, sloping, etc.). It has to control the existing vegetation long enough to allow the seeded plants a chance to become established and it should

conserve moisture. An interseeder that meets all of these criteria was developed at South Dakota State University in 1979. It has been tested on over 60 acres of native rangeland including four extremely rocky sites. Its performance has been excellent.

The new interseeder incorporates the agromical principles of an older South Dakota interseeder, but is a very simple machine, designed from proven component parts.

The South Dakota interseeder has chisel

plow shanks mounted on a main frame, seed pipes behind the chisel plow shanks, a chain drag, and brackets and plates for mounting the seed hoppers. The seed boxes are driven hydraulically. All chisel plow sweeps are positioned to throw soil away from the center of the main frame. Depth control is through gage wheels. The interseeder is mounted on a 3-point hitch.

Since its introduction in 1979, three ranchers have built the drill and three counties are building the drill for farmer use.



Forage and pasture committee 1967-70:(standing) M.D. Rumbaugh, alfalfa breeding; E.J. Williamson, Extension forage fertility; P.L. Carson, soil fertility; J. Sanderson, farm management; (sitting) R.A. Moore, pasture research; F.C. Westin and L.A. Derscheid, co-chairmen; J.G. Ross, grass breeding (Photo 1969).

CHAPTER XXVI MILLETS, KOCHIA, HAY

Milletts were tested extensively during the late 1890s and the early 1900s. In fact, the first plant breeding was done with foxtail millet. Kochia was tested as a forage crop during the 1940s and several experiments involving hay quality were conducted during the 1940s and 1950s.

MILLETS

Considerable emphasis was placed on millet for several years. Seed from 40 seed sources was planted in 1897 by D. A. Saunders, who classified them as common, Hungarian, barnyard grass, golden wonder, broom corn (proso), and German millet (Bul 60). Millet was compared with other crops as a feed for baby beef production in 1905. It did not compare favorably with oats or especially corn (Bul 97).

In 1899, D. A. Saunders planted 1/4-acre plots of Kursch foxtail millet and several broom corn (proso) millets--Red Orenburg, Black Russian, Red Veronezk, Red Russian and Tambov at the new Cooperative Range Experiment Station at Highmore (Bul 66). The next year Saunders and L. W. Carter planted Japanese barnyard and White Russian and Black Veronezk proso millet (Bul 70).

After 6 years of testing at the Highmore Substation, W. A. Wheeler and S. Balz concluded in 1905 that barnyard grass did not have enough quality to warrant further testing and that pearl millets were too late in maturity for that area, but foxtail and proso millets had given good results (Bul 96).

In 1904 Wheeler and Balz started work to improve the foxtail millets--German, Hungarian, Siberian and Common. A number of selections of individual plants was made from the varieties grown that year. Seed from individual plants was seeded in centgener rows. Over 200 centgener rows were planted. Each contained about 130 plants, but only 100 plants in the middle of the row were used for centgener records (Bul 96).

Breeding work with proso millets (White Ural, Black and Red Russian, Black and Red Veronezk, Red Lump, Tambov, Red Orenburg and Early Fortune) began in 1906. Selection rows were sown by Wheeler and Balz from 15 sources representing nine original varieties (Bul 101). More uniform strains were doubtlessly developed, but there is no indication that they were given variety names.

In 1915 N. E. Hansen said that a number of proso millets could profitably be raised in any part of the state. He reported that Nola

K. Fromme of the Home Economics Department had used white proso to prepare Proso soup, Proso mush, Proso nut loaf, Proso molasses bread, Proso cooked in fireless cooker with dates, Proso with cheese, and Proso muffins that were served to over 100 South Dakota farmers who attended the farm and home course at SDSC in January 1915. The general verdict was very favorable as to the good flavor of all the foods. Recipes for the above items as well as several puddings, rolls, brown and sour milk breads, pancakes and cakes were also developed (Bul 158).

In 1919 J. W. Wilson and A. H. Kuhlman compared proso millet silage with corn silage for fattening steers. The results showed that as an emergency crop corn was superior to millet (Bul 189).

Milletts were planted for 20 years at the substations. However, the yield of grain was not equal to that of amber cane or corn, and forage production was less than for amber cane and sudangrass (Bul 285).

Milletts were tested as competitive crops for controlling perennial weeds, but were less effective than rye, sorghums or close-drilled soybeans.

Consequently, millet never became a major crop. Though a small acreage was planted most every year, they were used primarily as emergency crops because they could be seeded as late as July and still produce a crop. During years when weather conditions prevented planting spring-seeded crops on time or years when these crops were destroyed by insects or hail, millet was in great demand.

KOCHIA FOR FORAGE

Kochia was an early emerging drought-tolerant annual weed that E. L. Erickson tested for its value as a forage crop from 1940 to 1946.

Protein content of hay was almost as high as for alfalfa, fiber content was lower, and ash content higher. Hay yields were higher than for foxtail millet. Kochia was palatable. Cattle grazed it readily and a cow consumed up to 72 pounds of hay a day.

When wethers were fed several types of hay free choice, they consumed 1.36 parts of kochia to 1 part of bromegrass and 0.87 parts to 1 part of alfalfa. Western wheatgrass hay was not eaten. In digestion trials with sheep, the TDN was 57% for kochia, compared to 51% for alfalfa. In two other trials the

average digestible coefficients for protein were 62 and 65 for kochia, and 64 and 66 for alfalfa. When compared to alfalfa for wintering beef heifers, alfalfa was superior for gains and for amounts of feed refused (Bul 384).

When kochia was self-pollinated, four distinct genotypes were obtained which were true-breeding for at least one generation.



Kochia space planting on West Farm in 1941.

FREQUENCY OF HARVESTING NATIVE HAY

A. N. Hume initiated a native grass harvesting study in 1942. It was continued by J. G. Ross for several years in the 1950s after Hume retired and for a few years by R. A. Moore (FS 64).

Experiments were conducted at substations near Cottonwood and Eureka to determine how frequently native hay should be cut to get good yields of high quality hay and still leave the grasslands in good condition. The Eureka experiment was terminated in the 1960s but Ross continued the study at Cottonwood until the mid-1970s.

One series was cut for hay each year, the second series every other year, and the third series was cut once every 3 years. Results of the first 10 years indicated that harvesting every 2 years was most desirable from the standpoint of yield, cost of harvesting and maintenance of desirable grasses. However, during the next 10 years, harvesting every 3 years began to show an advantage.

Effects on Yield and Quality

Average annual yields over the first 18-year period at both Cottonwood and Eureka increased with an increasing time interval.

Average protein content over 6 years was 8.86% for annual harvests at Cottonwood, 7.65% for biennial harvests and 7.45% for the triennial harvests. Similar figures for Eureka

were 8.88%, 7.56% and 7.35% (FS 64).

Changes in Grass Species

The percentages of certain grass species from areas harvested annually, biennially, or triennially were obtained for a 14-year period.

At Cottonwood the amount of high yielding midgrass, western wheatgrass, declined to 6% in the annual harvest while it constituted 15 and 25% of the forage in areas harvested biennially and triennially. The shortgrasses, bluegrama and buffalograss, increased to 36% with annual harvesting while making up 31% and 16% with biennial and triennial harvesting, respectively (FS 64).

The infestation of Japanese chess was more acute in the triennially harvested areas. The percentage of forbs, non-grassy plants, tended to decrease with longer intervals between harvests (FS 64).

At Eureka the composition of hay was different, but the same type of change took place. Western wheatgrass and green needlegrass increased with longer intervals between harvests while bluegrama and western needlegrass decreased (FS 64).

Smooth brome grass invaded the areas and the invasion was more marked on areas where delayed cutting was practiced (FS 64).

EARLY-, MEDIUM- AND LATE-CUT NATIVE HAY

Prairie hay was a major source of harvested feed for cattle and sheep in many areas of South Dakota, and several experiments were conducted to determine the feed value of the forage when harvested at various stages of growth (Bul 457).

Chemical Composition

O. E. Olson and G. F. Gastler of the Biochemistry Department obtained about 100 samples of prairie hay from the Range Field Station at Cottonwood, the North Central Substation at Eureka, and the Central Substation at Highmore, from 1947 to 1950. About one third of the samples were cut at each of three stages of maturity--early, medium and late.

Chemical analyses showed a serious decline in protein and phosphorus content of hay as it matured. Other nutrients did not change appreciably (Bul 457).

Digestibility

L. B. Embry of the Animal Husbandry Department conducted digestion trials from 1950 to

1952. Trials were conducted at Cottonwood with the hay cut at two stages of growth in 1 year; and at Eureka with hay cut at three stages of growth in 3 years. Rations, with each kind of hay, were fed with several methods: unsupplemented, equalized in protein at about 10% and supplemented to provide various levels of protein.

In each trial the digestibility of various nutrients decreased as the stage of maturity of grass increased. The greatest decrease in digestibility was found in protein, which perhaps is the most important single nutrient in hay and the most expensive to replace (Bul 457).

Feed Value

Embry conducted winter feeding trials with calves at the three substations from 1950 to 1953. Early-, medium- and late-cut prairie hay were supplemented with soybean meal pellets to bring the protein level to 10%.

Similar rates of gain were obtained by supplementing hay with different rates of high protein supplement. Two pounds of soybean meal pellets were required for late-cut hay, while only half as much was needed for early-

cut hay to obtain a ration containing 10% crude protein. This lowered the value of the more mature hay. Value ranged from \$20 per ton for early-cut hay, to about \$17.50 for medium-cut hay, and \$11.30 to \$14.30 for late-cut hay (Bul 457).

Mow or Graze

At Reed Ranch, in Lyman County, some native grass was cut when heading and left in windrows, while a similar amount of grass was left standing. Samples were taken from both the windrowed hay and standing grass at intervals between July 13 and December 7. They were analyzed for protein, phosphorus and carotene content.

During the 5-month period, protein content of windrowed hay declined about 1.9% while that of standing grass dropped 5%--from 8 to 3%. Phosphorus content in windrowed hay remained unchanged (about 0.16%) but dropped drastically in standing grass after the first killing frost and was below 0.06% by December 7. Carotene content of windrowed hay dropped almost 50% during the first month and about 65% in 5 months, while the content of standing grass decreased 75% by September 6 and 100% by December 7 (Bul 457).



D.L. Leek and one of his two Percheron Stallions on County-Line Farm, built in 1910, nine miles south of Iroquois (Photo about 1915).

CHAPTER XXVII SOIL MANAGEMENT

Studies involving depth of tillage and fallow were a part of the early crop rotation studies. Depth of tillage and crop residue management were included in others. In addition several studies involving minimum tillage, stubble mulch tillage and contour farming tillage have been conducted.

DEPTH AND DATE OF TILLAGE

A subsoil plow was first used at the Experiment Station in 1893. It was necessary to plow the field to a depth of about 6 inches before using the Deere "Iron King" which operated best at a depth of 12 to 20 inches. Because two operations were required, the Deere "Secretary" was developed in 1896. It apparently plowed the topsoil and loosened the subsoil in one operation (Bul 54).

After using the "Iron King" for 4 years, it appeared that land that had been subsoiled absorbed more moisture which caused the soil to be cooler and produced more vigorous plants that were more apt to lodge; but use of the implement did not improve crop yields except during dry years (Bul 54).

During a 21-year period (1912-1932) at the Cottonwood Substation, corn, sorghum, winter wheat and rye were grown in experiments established by A. N. Hume. The long-time average yield was about one bushel per acre higher from plots plowed at a depth of 5 inches than from plots plowed 10 inches deep (Bul 312).

Also at the Cottonwood Substation, spring wheat, oats and barley were grown on areas that had been plowed or double disked in a long-time continuous cropping system. Spring wheat produced 1 bushel per acre more on disking and spring plowing; barley about 1 bushel more on spring or fall plowing than on disking; while oats yield was 3 bushels higher on fall plowing (Bul 312).

In experiments initiated at the Belle Fourche Field Station in 1909, spring and winter wheat, oats, barley and corn were grown continuously using four tillage methods and by alternate fallowing and cropping. The four tillage methods were (1) fall plowing, (2) fall plowing at 8-inch depth followed by subsoiling in alternate furrows to 16-inch depth, (3) hard ground listing during the fall and (4) shallow plowing (Cir 85).

Major findings pertaining to tillage were as follows:

1. The yields of all crops on the heavy gumbo soil were greater on fall-plowed than on

spring-plowed land. The advantage in favor of fall plowing was more pronounced with small grain and sorgho than with corn.

2. Depth of plowing had very little influence on crop production. Plowing to a 7- or 8-inch depth resulted in slightly larger yields of most crops than plowing 4 inches deep. Subsoiling to a depth of 16 inches had no apparent effect on crop yield.

3. The yields of all small grains on disked corn land were greater than on fall- or spring-plowed land. Yield of winter wheat grown on disked corn stubble was 42% higher than on fall-plowed continuous wheatland.

4. Small grain yields on summer fallow exceeded those on fall plowed grain stubble or disked cornland.

5. The average yields of spring wheat and oats following the plowing under of different green-manure crops were lower than after fallow. Sweetclover growing later into the season depleted the soil moisture reserves more than the other crops and depressed grain yields.

6. The average yield of corn grain on clean fallow for the period was 10.3 bushels per acre. Corn failures on summer fallow were below 4%--less than on any other tillage method under trial (Cir 85).

From 1913 to 1932 in a corn-spring wheat-sweetclover rotation at the Highmore Station, A. N. Hume used a moldboard plow at depths of 4, 6, 7, 8, 10 and 12 inches, a subsoiler at a depth of 10 inches and a disk-deep tiller. Greater total weights for each of the three crops were produced from plowing 7 or 8 inches deep in preparation for corn. Subsoiling (soil not turned over) gave larger crop production than plowing at a 4- or 6-inch depth but lower yields than plowing at greater depths (Bul 369).

In 1913 Manley Champlin handled native sod on the Vivian Substation in three ways: (1) plow 3 inches deep, (2) double disk before plowing 3 inches deep and (3) double disk and plow 6 inches deep. Some sod breaking was done on each of two dates. The production from corn and oats in 1914 seemed to favor 6-inch breaking early in the season. Yields were no better for double disking operations (Bul 162).

At the Belle Fourche Field Station from 1923 to 1948, fall and spring plowing were compared with hard ground listing for use in

preparing a seedbed from small grain stubble for corn. Duckfoot cultivation was compared with plowing from 1932 to 1948. Average corn yield on listed land was equal to that on spring plowing but considerably lower than on fall plowing. There was no difference between the yields produced on duckfooting and plowing over a 16-year period (Cir 85).

Leo Puhr compared three depths of plowing in a corn-oats-wheat rotation at Brookings from 1942 to 1961. Corn yield was higher if the soil was plowed at a 7-inch depth than when plowed 4 or 10 inches deep (Bul 508).

During the same period he compared subsurface tillage with plowing at Highmore in a sorghum-wheat-oats rotation. Over a 20-year period, average small grain yields on plowing were 6 to 7 bushels higher for oats and 1 to 2 bushels higher for spring wheat (Bul 513).

In 1976 Q. S. Kingsley wrote, "Chisel plowing does not control winter annual weeds in fall-sown winter wheat, barley, or rye in South Dakota. However, winter wheat sown into relatively weed-free fields with adequate standing mulch yielded as much or more than spring wheat."

FALLOW

A year of fallow by plowing in July and again in the fall was included in several crop rotations initiated at Brookings by E. C. Chilcott in 1897. Five years later it was concluded that fallowing was impractical at that location. Crop yields were somewhat higher after fallow, but not enough to offset the loss of a crop during the fallow year (Bul 79).

On dryland at the Belle Fourche Field Station crop yields were higher on fallow than on continuous cropping by 8 to 10 bushels for small grains and 5 to 7 for corn (Cir 85).

Spring wheat, oats, barley, emmer, winter rye, winter wheat and flax were grown for 19 years in rotations that were initiated at Highmore in 1912 by A. N. Hume. The three rotations were continuous cropping, fallow-small grain, and corn-small grain-sweetclover.

Highest average small grain yields were obtained when planted on fallow or corn ground. Yields of corn and small grain were slightly higher in the 3-year rotation than in the 2-year rotation. However, the latter was the most profitable rotation for all crops because yield increases did not offset the loss of a crop during the year of fallow or sweetclover (Bul 272).

CROP RESIDUE MANAGEMENT

In 1942 Leo F. Puhr initiated an experiment on the Agronomy Farm that lasted for 20 years. Six residue treatments and subsurface tillage were compared with two residue treatments and plowing for corn and wheat production in a corn-oats-wheat rotation. Crop residue, except for a 6-inch stubble, was removed in one treatment but all residues were returned in the other five treatments with (1) manure added, (2) nitrogen added (3) phosphorus added, (4) nitrogen and phosphorus added, and (5) nothing added. Residues were removed in one plowing treatment and plowed under in the other.

On subsurface tilled plots, corn yields were higher where residues were removed, especially during dry years. When residues were returned, corn yields were increased by the addition of manure or fertilizer. Corn yields were also higher on plowed plots where residues were returned (Bul 508).

Puhr also compared plowing, subsurface tillage, one-way disking and double disking in a 3-year rotation at Brookings from 1942 to 1961. Yields of corn, oats and wheat were higher from plots that were plowed than from those that were sub-surface tilled if the crop residue was returned to the soil. However, yields were similar if the residue was removed from the plot. Yields were even lower where the plots had been one-way disked or double disked. If the soil fertility level was adequate, tillage method had little effect on small grain yields (Bul 508).

At the Highmore Substation Puhr superimposed three crop residue treatments on spring wheat-sorghum and spring wheat-fallow rotations. All crop residues were returned in one treatment. All residue except a 6-inch stubble was removed in the other treatments, but 8 tons of manure per acre were applied in one of those. Over a 20-year period (1942-1961), crop residues and the use of barnyard manure slightly increased yields in the wheat-fallow-rotation, while the addition of manure increased wheat yield in wheat-sorghum rotation (Bul 513).

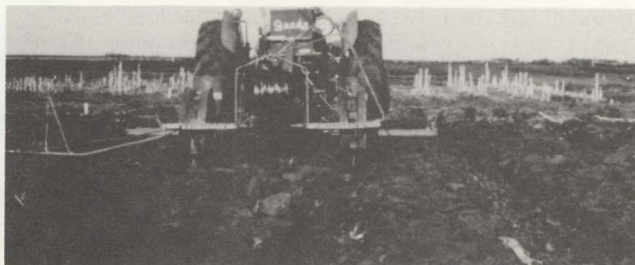
MINIMUM TILLAGE FOR CORN

During the 1950s herbicides were developed that gave relatively good control of annual weeds and reduced the need for row-crop cultivation. Also, new machinery was developed, and researchers tested methods of planting corn that reduced the number of tillage operations needed to prepare a seedbed.

From 1959 to 1961, Fred E. Shubeck conducted four experiments in Brookings County.

Conventional planting was compared with wheel-track planting, plow planting, strip processing and hard ground listing.

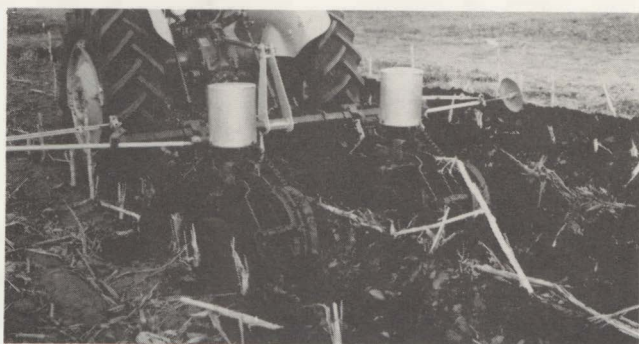
With wheel-track planting, plowing with a moldboard plow was the only operation used for preparing a seedbed. Tractor wheel width was adjusted so that corn rows were planted in the wheel tracks. (Bul 526).



Plow planting.

With plow planting, plowing and planting were done in one operation. The planter was pulled directly behind the plow. Yields from both methods were similar to those from conventional planting, and costs were reduced about 40% (Bul 526).

Hard ground listing was done on unplowed ground. Corn was planted in furrows. Strip processing was similar except that only a narrow strip was tilled in which corn was planted. The costs were about 40% as high as for conventional planting but yields were lower primarily because of poor weed control (Bul 526).



Hard ground listing.

Q. S. Kingsley and Shubeck compared wheel-track planting, plow planting, listing and subsurface tillage with a Noble blade from 1962 to 1967 at the Southeast South Dakota Experiment Farm. In these experiments, simazine was applied preemergence to control annual weeds. Again, the yields were inferior from strip processing, listing and subsurface tillage (Bul 526 & FS 526).

Shubeck also compared spring and fall operations with the chisel plow and moldboard

plow for continuous corn and corn-soybean rotations at the Southeast South Dakota Experiment Farm. The chisel plow was equipped with curved chisels 22 to 30 inches long and 3 inches wide. This implement loosened the soil and covered about 30% of the crop residue. It appeared to break up the plow sole and claypan, increase moisture absorption, and improve aeration while leaving a mulch and rough surface to control soil erosion and water runoff (16th Ann. Rep. SE Farm).

With the chisel plow, corn and soybean yields were maintained while leaving sufficient crop residue on the surface to protect the soil from wind erosion. When the soil was wet, chisel plowing tended to compact the soil and form a poor seedbed. Normally, the soil was dry in the fall so that a chisel plow could be used. The soil surface was protected more from wind erosion by chiseling than with a moldboard plowing (16th Ann Rep SE Farm).

Corn production costs were less with minimum or reduced tillage although herbicide was needed to control weeds. Zero tillage was not very successful in a corn-soybean rotation because weeds were difficult to control and some of the more effective herbicides reduced the yield of the following crop (16th Ann Rep SE Farm).

At Elkton Edward J. Williamson compared three tillage systems for corn production for 4 years beginning in 1974. Actual 1978 comparisons for machinery and fuel costs were \$8.73 per acre for conventional tillage (stalk chopper, moldboard plow, disk, harrow, two cultivations and ammonia sidedressing), \$7.31 for reduced tillage (chisel plow instead of moldboard), and \$5.40 per acre for "no-till" (chopper, till planter, two cultivations and ammonia). Gas requirements were 4.60, 4.55 and 2.88 gallons per acre, respectively (FS 703).

CONTOUR FARMING

The amount of soil erosion and water runoff can be reduced by farming across the slope.

In 1968 eleven conservation districts provided funds to conduct a demonstration on the West Prairie Coteau Research Farm near Garden City. Edward J. Williamson and Quentin S. Kingsley established a demonstration that included rotations of corn-oats and corn-oats-alfalfa-alfalfa-alfalfa with farming operations up and down the 5% slope and the 2-year rotation across the slope. Two plots were fallowed continuously.

Each of the 14 x 72-ft plots was enclosed on the sides and upper end with corrugated



Oats planted on contour (across slope).



Crops planted up and down slope.

sheet metal. A sunken concrete collecting tank across the lower end of each plot received all runoff. The overflow was piped to two submerged 55-gallon barrels. The collecting system could accommodate a 9-inch runoff. After each rain the collected runoff was measured and sampled for soil-density determination, and the tanks were cleaned (FS 627).



Water runoff and eroded soil collection system.

Runoff and soil loss were the greatest under fallow, where the soil surface had no residue protection, followed by the corn row crop, where the soil surface was exposed to rainfall during the early part of the growing season, and next by the small grain crop, oats. Only negligible amounts of runoff and soil loss were evident with the first and second year alfalfa crop (FS 627).

Switching the direction of farming from up-and-down slope to across-the-slope, or contour farming, reduced runoff and soil loss for corn by 29 and 51% and for oats by 82 and 74%, respectively (FS 627).

MANAGING CLAYPAN SOILS

Since many soils in the James River Basin have a tight clay layer which makes it difficult for water, crop roots and machinery to move through the soil, a farm was leased near Plankinton, South Dakota, for experiments. A winter wheat-corn-oats-spring wheat rotation was established by Burton L. Brage in 1957 and terminated by Dwight Hovland in 1961 (FS 159).

The sodium-rich dense claypan limited corn growth but had less effect on small grain. Small grain grew during the season when rainfall was more abundant so that the subsoil water below the restricting claypan was not needed as much as with corn. Nitrogen fertilization of claypan soils increased crop yields during years free from drought (Brage).

Chiseling to a depth of 20 inches and summer fallow were expensive operations that did not improve yields. The use of 1 or 2 years of alfalfa in a rotation substantially reduced profit. It was suggested that alfalfa should be left in the same fields for at least 5 years (FS 159).

Quentin S. Kingsley deposited chopped straw and other types of trash into trenches cut into the claypan on a farm near Redfield during the 1960s.



Depositing organic matter in subsoil trenches.

Incorporation of trash into vertical subsoil trenches increased the infiltration and conservation of water in the soil. The wedge of organic matter encouraged root development beneath the claypan. Yields were greater when the organic matter was placed in the wedges than when it was plowed into the surface layer (Kingsley).

During the mid-1970s L. O. Fine and P. D. Weeldreyer used deep plowing for corn production on a farm near Redfield. Plowing claypan at a depth of 30 inches in 1970 made it possible to raise 129 bushels of corn per acre under irrigation in 1977. With normal plowing depths only 56 bushels were produced under irrigation and 43 without irrigation, indicating that deep plowing had long-time beneficial effects in claypan.

Subsoil and surface soil structure forms as the soil dries and cracks into fragments. If the subsoil shrinks and swells slightly and there is ample organic matter, then spherical granules form. If the shrink-swell capacity is large, dense blocks are formed by fragments swelling against one another. Vertical cracks form in subsoils as the soil dries. The cracks surround polygonal

prisms which gradually increase in size with soil depth. In Central and Western South Dakota, deep-rooted plants such as alfalfa remove available soil water to a depth of more than 10 feet and large wide cracks are formed around the prisms. Surface soil may fall into the cracks to form deep holes that are locally called "sink holes" (White).

Some range plant species tend to grow on certain soils. Their distribution is controlled by moisture and by the interaction of soil fertility, texture and structure. Native grasses growing on or near soils with sodium-dispersed claypans adsorb more magnesium and potassium than calcium and sodium relative to the amounts readily available in the soil. Apparently, grasses in claypan soils do not move sodium to the soil surface (White).



Plowing on a large farm in 1930s.



Plowing prior to 1943.

CHAPTER XXVIII SOIL CHEMISTRY AND FERTILITY

Soil variabilities in South Dakota created differences in soil chemistry and fertility in the many areas of the state. Soil development is an interaction of five factors: parent material, climate, vegetation, relief and time. The variations in parent material had an effect on the type of vegetation, but climate had a greater effect. Vegetation, in turn, influenced the development of the soil.

Originally the land surface of most of the state was composed of Pierre shale. However, glacial ice entered the state from the north-east or north and flowed south and west, covering the area east of the Missouri River. As a result, the state was generally divided into two types of parent materials, the "gumbo" of West River and the glaciated till of East River.

Average annual rainfall ranged from 26 inches in the southeast to 13 inches in the northwest part of the state, while average air temperatures ranged from 48° in the south to 44° along the northern border. The lines of equal temperature and equal precipitation crossed roughly at right angles. Relatively speaking, this made the southeast warm and moist, the northeast cool and moist, the southwest warm and dry, and the northwest warm and very dry. These climatic differences determined the type of vegetation which then affected soil development (Bul 656).

The native grasses determined the amount of organic matter in the soils. In general the taller grasses left relatively larger amounts of organic matter in the soils. Moving westward the rainfall diminished, grasses size decreased and lower amounts of organic matter were left in the soil. Temperatures also played an important part. In the cooler northern part of the state, more organic matter and total nitrogen were present than in southern areas with equal precipitation. This was due to slower biological decomposition and chemical activity under the cooler temperatures (Bul 656).

Nitrogen is one of the elements used in large amounts for crop production. Since it and other essential nutrients existed in varying amounts in soil types of the state, the soil chemistry and fertility varied considerably from one area to another. Consequently, it was necessary to conduct research in many areas in order to determine fertility levels and steps needed to correct any deficiencies in each area.

PERSONNEL

Staff Members

Howard Loomis	1910-1920
J. G. Hutton*	1911-1939
A. L. Bushey	1924-
Dr. L. F. Puhr*	1927-1962
Ralph Arms	-1947
Dr. L. O. Fine*	1946-
E. J. Williamson*	1947-1948
E. J. Williamson (USDI)	1948-1953
P. L. Carson*	1948-
Dr. B. L. Brage	1950-1959
R. C. Dodge	1956-1961
Dr. F. E. Shubeck	1951-1960?
P. Fruen	1956-1961
Dr. D. R. Hovland	1960-1970
R. I. Papendick	1959-1960
E. J. Langin	1961-1963
R. D. Heil	1961-1964
R. C. Ward	1962-1972
E. J. Diebert	1967-1968
Douglas G. Koth	9/67-1972
B. Byrnes	1972-1974
R. H. Gelderman	1974-

Graduate Students

Leo F Puhr	M.S.	1925-1927
Ralph Arms	M.S.	** -1947
Edward J. Williamson	M.S.	** -1953
Merle Switzer	M.S.	1949-1951
R. Gene Gresham	M.S.	1952-1954
Daniel Norgaard	M.S.	1952-1954
Fred Kurpjueit	M.S.	6/1/54-4/6/56
Paul H. Baxter	M.S.	1955-1957
Milo I. Harpstead	M.S.	8/1/55-3/20/57
Wayne Lemke	M.S.	4/15/55-5/15/57
Lloyd L. Davis	M.S.	1955-1957
Reinder U. Mesdag	M.S.	1957-1959
Paul Fruen	M.S.	** -1961
John Mortvedt	M.S.	1958-1960
Abbas Tabatabai	M.S.	1959-1961
Gary Spalding	Ph.D.	1961-1964
Dean E. Wesley	Ph.D.	9/11/61-6/6/65
Roger Swanson	M.S.	1/9/63-1/9/65
Edward J. Diebert	M.S.	1965-1967
Anthony V. Salomi	M.S.	? -1967
Timothy O. Fadoymi	M.S.	-1967
Douglas G. Koth	M.S.	** -1972
James Pfeiffer	M.S.	1969-1971
Raymond C. Ward	Ph.D.	** -1972
Gregory Grenz	M.S.	1969-1972

- * Project leader
- ** Full-time assistant while doing graduate work.

potassium, either singly or in combination with other elements, did not improve yields enough to pay for the expense involved (Bul 280).

O	N	P	K	O	NP	NK	PK	NPK	O
140	141	142	143	144	145	146	147	148	149

Fertility test at Brookings--corn-oats-wheat-barley-red clover.

At the end of 30 years (1938) the conclusions were essentially the same. Average seed yield increases for all crops were about 26% from phosphorus, 11% from nitrogen, 3% from potassium, and 15 to 16% from combinations that included either nitrogen or phosphorus. Wheat gave greater responses to P and PK, while barley yield was increased by all phosphorus treatments. Oats gave little or no response to treatments that included nitrogen or potassium. Corn responses were slightly below the average for all crops for all treatments except for N and NK (Bul 325).

O	N	P	K	O	NP	NK	PK	NPK	O
150	151	152	153	154	155	156	157	158	159

Fertility test at Brookings--corn-wheat-barley-oats-red clover.

Highmore Substation

The crop rotation used at Highmore was corn-wheat-oats and peas for hay-grain sorghum-oats-alfalfa for 5 years on 2- x 8-rod plots. Fertilizer treatments were the same as at Brookings.

O 111	O 201	O 301	O 401	O 501	O 601
N 112	N 202	N 302	N 402	N 502	N 602
P 113	P 203	P 303	P 403	P 503	P 603
K 114	K 204	K 304	K 404	K 504	K 604
O 115	O 205	O 305	O 405	O 505	O 605
NP 116	NP 206	NP 306	NP 406	NP 506	NP 606
NK 117	NK 207	NK 307	NK 407	NK 507	NK 607
PK 118	PK 208	PK 308	PK 408	PK 508	PK 608
NPK 119	NPK 209	NPK 309	NPK 409	NPK 509	NPK 609
O 120	O 210	O 310	O 410	O 510	O 610

Soil fertility test diagram at Highmore.

After 25 years Hutton concluded that both nitrogen and phosphorus were limiting factors in crop production and that an application of potassium generally depressed crop yield. Though grain yield of corn and wheat was not increased by any fertilizer treatment, all other crops responded to treatments that

included both nitrogen and phosphorus (Bul 325).

Cottonwood Substation

The same fertilizer treatments used at Brookings and Highmore were applied on 2- x 8-rod plots of a 3-year rotation of corn-wheat-legume grown on North Farm.

After 25 years Hutton concluded that potassium produced the greatest yield increases followed by nitrogen, but response was too small to make their use economically feasible. Phosphorus had a depressing effect on yield (Bul 325).

Eureka Substation

As at Highmore and Cottonwood, a rotation of corn-wheat-sweetclover on 2- x 8-rod plots, was used by J. G. Hutton for 25 years of soil fertility investigations. Yield responses were not obtained from the application of nitrogen, phosphorus or potassium, and the application of all three increased yields by less than 1%. He concluded that plant food in the soil from 1912 to 1936 did not limit production (Bul 325).

O 101	O 201	O 301
N 102	N 202	N 302
P 103	P 203	P 303
K 104	K 204	K 304
O 105	O 205	O 305
NP 106	NP 206	NP 306
NK 107	NK 207	NK 307
PK 108	PK 208	PK 308
NPK 109	NPK 209	NPK 309
O 110	O 210	O 310

Fertility test diagrams--Cottonwood & Eureka.

MANURE, PHOSPHATE AND LIMESTONE

From 1912 to 1937, Hutton used Hatch funds for a fertility experiment on East Farm at Brookings. The objectives of the experiment were (1) to determine the effectiveness of acid phosphate when applied alone and rock phosphate when applied with manure, and (2) to determine the effect of limestone when applied alone, with manure and with manure and either type of phosphate (Bul 325).

About 4 acres of East Farm were divided into 1-acre blocks of 1/10-acre plots and planted to a 4-year rotation, corn-oats-winter wheat-legume. Manure and limestone were applied alone and in combination with one

O	240
M	241
MAP	242
MRP	243
O	244
L	245
LM	246
LMAP	247
LMRP	248
O	249

O	340
M	341
MAP	342
MRP	343
O	344
L	345
LM	346
LMAP	347
LMRP	348
O	349

O	440
M	441
MAP	442
MRP	443
O	444
L	445
LM	446
LMAP	447
LMRP	448
O	449

O	540
M	541
MAP	542
MRP	543
O	544
L	545
LM	546
LMAP	547
LMRP	548
O	549

R	360
RL	361
RLP	362
RLK	363
RLPK	364
O	365
M	366
MP	367
MK	368
MPK	369

R	460
RL	461
RLP	462
RLK	463
RLPK	464
O	465
M	466
MP	467
MK	468
MPK	469

R	560
RL	561
RLP	562
RLK	563
RLPK	564
O	565
M	566
MP	567
MK	568
MPK	569

Manure, phosphate and limestone test diagram.

another. Manure was applied with both types of phosphate and with lime and both types of phosphate. Manure and phosphate were plowed under during the fall when preparing the seedbed for corn, while limestone was applied before plowing oats stubble for winter wheat (Bul 325).

When the study was terminated, Hutton concluded that the application of 10 tons of manure every 4 years increased total seed yields by 11.25%, total straw by 10%, and stover and hay yields 21.5%. Grain yields were increased 10% for corn, 8% for oats, 30% for wheat and 30% for hay yields of clovers. Acid phosphate increased crop yields slightly, rock phosphate did not produce a response and limestone depressed yields.

Manure apparently supplied nitrogen and phosphorus in approximately the correct ratio for this stage of the changing soil fertility status. Earlier responses had been to phosphorus alone. Now, nitrogen response was becoming more of a factor in crop growth.

GRAIN AND LIVESTOCK FARMING SYSTEMS

In 1913 Hutton established an experiment on three 1-acre blocks of 1/10-acre plots on West Farm. He attempted to determine (1) the relative effectiveness of grain and livestock systems of farming and in maintaining soil productivity, and (2) the effects of applying certain amounts of phosphorus and potassium when applied with manure or with crop residues. He used a corn-oats-clover rotation. The crop residues included the straw left from oats and clover seed crops as well as corn stalks and peas that had been summer planted in the corn, but not harvested (Bul 325).

After 25 years, when the experiment was terminated, Hutton was not certain if soil fertility had been maintained. But crop yields indicated that a grain-livestock system was more effective than a grain system (Bul 325).

Grain and livestock farming test diagram.

NEWELL FIELD STATION

Crops were grown in planned sequences on dryland at the Newell Field Station starting in 1909. Crop yields on land continuously cropped declined. Beginning in 1936 manure at rates of 8 to 10 tons per acre was applied annually on corn. Also it was applied to sorghum grown in a sorghum-wheat rotation (Cir 85).

Yields decreased during the 47 years of cropping. The use of new varieties failed to maintain the productive capacity of the soil. Average crop yields from 1909 to 1932 were 2.5 bushels higher for spring wheat and corn and 9.5 bushels higher for winter wheat than those obtained from 1933 to 1955 even though seasonal and annual precipitation averages were similar for the two periods (ARS 45-15).

Irrigated rotations were initiated when water became available in 1912. They were terminated in 1950 when it was concluded that crop rotations alone did not maintain crop yields and soil productivity. Good yields could be maintained on clay soils only when a legume rotation was combined with adequate manuring and fertilizing, particularly phosphate. One did not work without the other (ARS-45-15).

In manured rotations all crops consistently outyielded those in unmanured rotations. However, sugar beets showed the greatest response to manure applications.

The lack of phosphorus was one of the major factors responsible for low crop yields in some rotations. In the long-time rotations, consistently high yields were obtained only when extremely high manure applications were made. Soil analyses and other supplemental studies indicated that 12 tons per acre per

year were required to maintain the phosphorus in the soil at the desired level (ARS-45-15). These and other studies indicated that an average application of 50 pounds of phosphate (P_2O_5) per acre per year were required to obtain maximum crop production on the irrigated Pierre clay soils.

COMPLETE FERTILITY INVESTIGATIONS 1942-1962

During 1942 Leo F. Puhr established soil fertility experiments on the Agronomy Farm and at the Highmore and Eureka Substations. He used similar crop rotations at all three locations.

Agronomy Farm

A corn-oats-wheat rotation was utilized until 1958 when it was changed to a corn-oats rotation. The fertilizer treatments included applications of nitrogen, phosphorus and potassium alone and in all combinations with one another including a combination of all three (Bul 508).

During the first 20 years of the experiment, soil fertility levels progressively declined under continuous cropping when no fertility maintenance practices were applied; consequently, the need for fertility practices increased with each successive year. Small grains gave more consistent response to fertilizer than corn (Bul 508).

It was stated in 1962 that annual applications of 40 pounds of nitrogen per acre for corn, and 20 to 30 pounds of nitrogen and 20 pounds of P_2O_5 for small grain would give maximum yields (Bul 508).

Highmore Substation

An experiment initiated in 1942 compared a cropping sequence of spring wheat-sorghum to a spring wheat-fallow rotation. All crop residues were returned to the soil in one treatment. All residues except for a 6-inch stubble were removed in two treatments and 8 tons of manure added annually in one of those (Bul 513).

In a second experiment, a spring wheat-oats-sorghum rotation was initiated in 1942. Fertilizer treatments of nitrogen and phosphorus alone and in combination were added during 1957. The experiment included two types of tillage for small grain stubble--moldboard plowing and subsurface tillage with a Noble blade (Bul 513).

By 1962 the results indicated that feed grains should be fertilized with moderate rates of nitrogen and phosphorus if no legume

was grown in the cropping sequence. Other suggestions included: (1) substitute sorghum for fallow if the feed can be used, (2) return all residues not used for feed to the soil, (3) incorporate all available manure into the soil, (4) apply phosphorus when raising small grain, particularly wheat, and (5) use nitrogen fertilizer when manure is not available or the crop does not follow fallow (Bul 513).

It was further suggested that 20 to 30 pounds of nitrogen and 5 to 10 pounds of phosphorus (10 to 20 lb P_2O_5) be applied annually with a fertilizer attachment to a grain drill (Bul 513).

Eureka Substation

The experiments at Eureka were similar to those at Highmore. The same crop residue treatments were applied to the same tillage treatments in crop rotations of (1) spring wheat-oats-sorghum, (2) wheat-sorghum and (3) wheat-fallow (Cir 124).

By 1956 manured plots yielded the most oats, and those where residues were returned were intermediate between manured plots and those where residues were removed. Cane yields were improved by returning residues to the soil. Wheat yields were not affected by soil treatment from 1942 to 1947, but manured plots produced 2 to 5 more bushels during the next 8 years. Manure and residues improved wheat yields more on subsurfaced plots than on plowed plots; oats and sorghum yields for a 14-year period and wheat yields during an 8-year period were higher on plowed plots than on subsurfaced plots (Cir 124).

OUT STATE TESTING

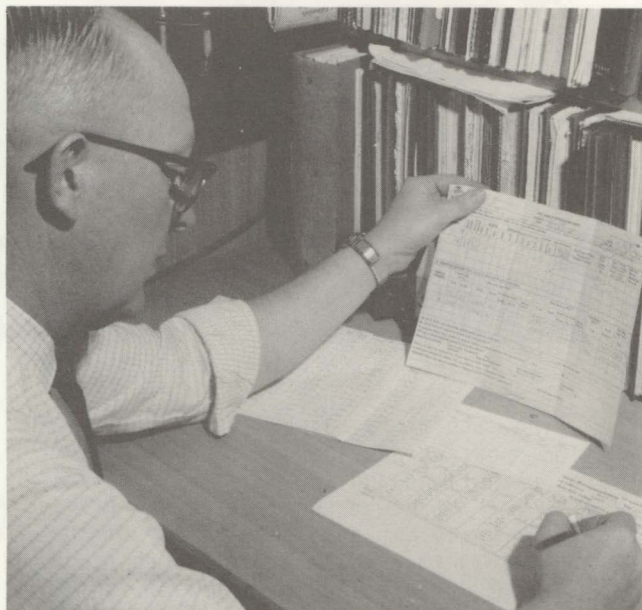
Starting in the early 1950s fertilizer experiments were conducted on privately owned farms. However, some fertility research personnel, such as B. L. Brage, F. E. Shubeck and L. O. Fine accepted other responsibilities and most of the work was conducted by personnel in the Soil Testing Laboratory and/or Extension specialists.



F.E. Shubeck and B. L. Brage harvest sorghum on soil fertility plots.

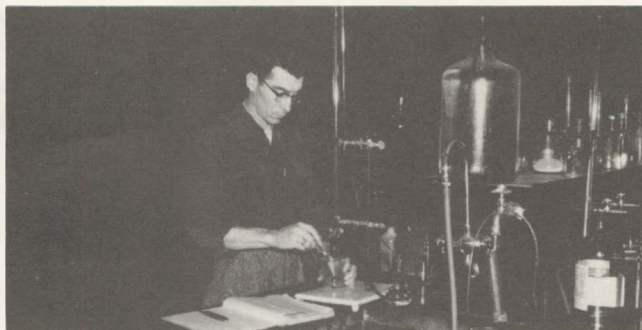
SOIL TESTING LABORATORY P. L. Carson

After the late 1940s much of the research on soil fertility was done by the personnel in the Soil Testing Laboratory. They conducted fertilizer trials so that the chemical analyses of farmers' soils samples could be compared with research data. Such correlations made it possible to give reliable recommendations for the use of fertilizer on soils represented by the samples tested.



P.L. Carson making soil fertility recommendations from soil test results

The 1947 legislature appropriated funds to establish a Soil Testing Laboratory to provide a soil testing service for the agricultural industry of South Dakota. E. J. Williamson was hired to start the laboratory on July 1. He began to assemble equipment, prepare educational materials and establish field experiments for soil test calibration purposes. In December he resigned to accept a laboratory manager position at SDSC with the Bureau of Reclamation.



E. J. Williamson conducting soil analysis.

The Soil Testing Laboratory position was filled in January 1948 by Paul L. Carson. The laboratory consisted of a Lamont Soil Testing Kit. An old storage room (Room 101 Administration Building) was cleared for a laboratory to be shared by the Soil Testing Laboratory and the Bureau of Reclamation. By spring this laboratory was functional and in operation.

Laboratory Staff

The Bureau of Reclamation laboratory was moved to Huron in 1953 and Williamson returned to the state Soil Testing Laboratory for approximately one year. He left to accept an assignment in the country of Jordan.

Joe Cholik was the first laboratory technician. Lee Rasmussen, Bud Dahl and Tom Schlackter followed.

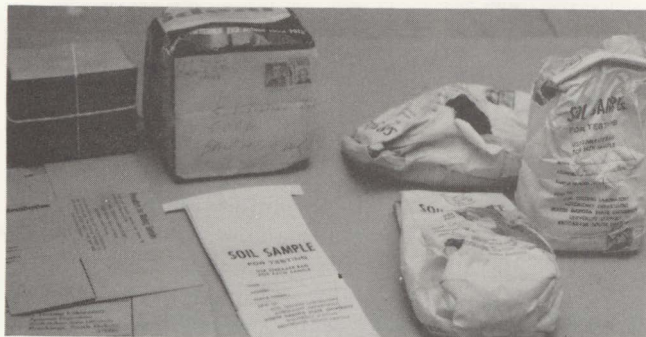
Many other students worked in the laboratory. Some, who later went on to obtain advanced degrees or to work in soils, were Larry Wilding, Dan Norgaard, Milo Harpstead, Rodney Dodge, Robert Papendick, Robert Heil, Dennis Heil, John Mordvedt, James Pfeiffer, Douglas Koth, Ed Diebert, Greg Grenz, Daryl Buholtz and others.



R.C. Dodge taking soil sample.

Betty Goff became the first full-time laboratory technician in 1955. She remained with the laboratory until 1956 when Rodney Dodge took the position. Dodge completed the course work and most of the research for his M.S. degree during that time. He resigned to work for CENEX in 1961. Raymond C. Ward then assumed the position until 1972 when he finished work for his Ph.D. degree and became manager of the Redfield Irrigation Station.

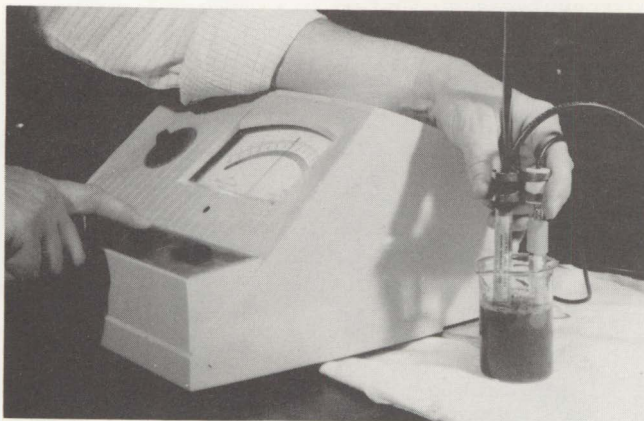
Bernie Byrnes assumed the managerial position in the Soil Testing Laboratory from 1972 to 1974 at which time Ron Gelderman became the manager.



Farmer's soil sample submitted for testing.

Laboratory Techniques

For several years at the beginning, the Bray Weak Acid Method was used to analyze for available phosphorus, the sodium-cobalinitrite method for potassium, a pH meter to determine pH and a solu-bridge for soluble salts.



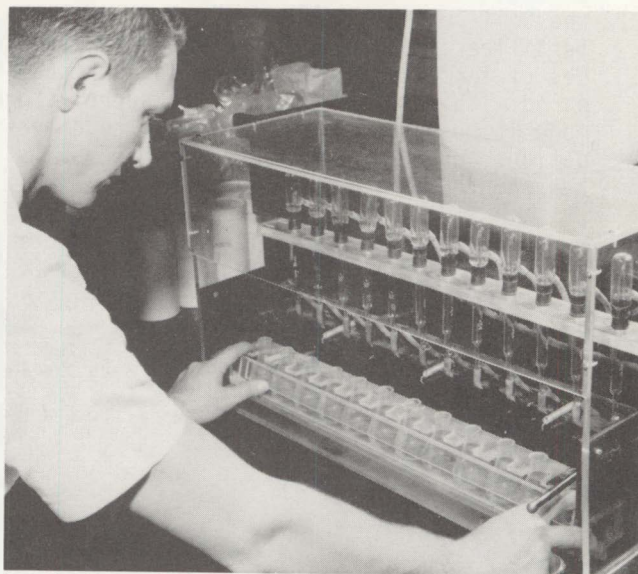
pH meter to determine soil acidity.

The flame photometer was added in 1949. This instrument made potassium determination much easier and more accurate. It also made the determination of sodium, calcium and magnesium much easier and was used by the Bureau laboratory in their cation exchange work.

The nitrate-nitrogen test developed by Ward was an improved method for evaluating nitrogen needs of farmer fields. His work contributed to the adoption of this test by soil testing laboratories throughout the Great Plains area.

Paul Fixen improved the accuracy of the phosphorus test for evaluation of soil samples. He also discovered some factors that influenced the use of the test that had not

been considered before and will need considerable evaluation in the future.



R.C. Ward--extraction solution for K test.

The laboratory started using the adsorption spectrograph in 1969 for minor element determinations and the $\text{NO}_3\text{-N}$ electrode in 1970 for nitrate determination. The $\text{NO}_3\text{-N}$ test greatly improved the ability of the laboratory to predict the nitrogen needs of crops, especially small grains.



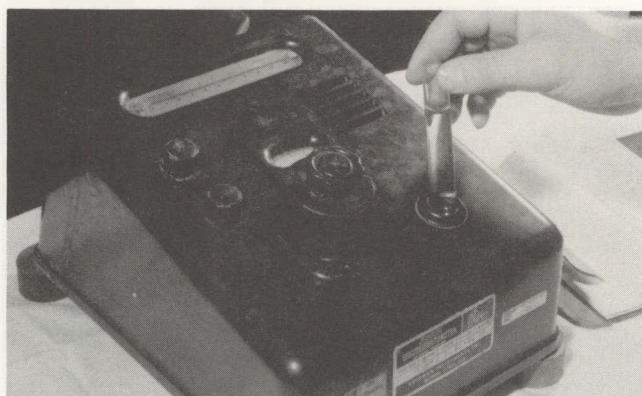
P.L. Carson using flame photometer.

Soil test-fertilizer recommendations were programmed for the computer in 1977. This programming was coordinated with North Dakota and Minnesota which resulted in better and more consistent recommendations for all three states.

Analyses

The Soil Testing Laboratory assumed the responsibility for water analysis for irrigation purposes after the Bureau laboratory was moved to Huron. This service was continued until 1969 when the water quality laboratory, established in the Water Resources Institute, started to provide this service.

The number of soil samples tested for South Dakota farmers varied from year to year. In the 1950s, the number varied according to the ASCS payment program. It gradually increased for over 15 years and ranged from 9,000 and 15,000 a year in the late 1970s. Most of the farmer samples were tested during September, October, November and December. Sometimes, March and April were big months depending on the weather encountered. A turn around time of 3 to 4 days from the time a sample was received at the laboratory until a recommendation was completed was maintained most of the time.



Colorimeter--test for P and organic matter.

During times when the laboratory was not busy with farmer samples, research samples (both soil and plant materials) were processed for the soil fertility and other research projects. Some plant analysis work was also done for farmers to try and determine if their fertility program was adequate.

Field Trials

When the laboratory was opened, very little field data were available for relating soil tests and field response to fertilizers. Work with L. F. Puhr was started to obtain these data. Greenhouse experiments were also established to relate soil tests to crop responses.

For many years greenhouse experiments and field trials were conducted by laboratory personnel exclusively or in cooperation with other soil fertility researchers.

However, in 1959 a position was added to help obtain field data to correlate with soil analyses. This position was filled for about a year each by Robert Heil and Robert Papendick. In 1961 Ed Langin took the position. When he left the position in 1962 to become Extension soils specialist, the position was eliminated.

During this period extensive soil fertility-soil testing field trials were established on private farms for the purpose of relating soil test values with growth and yield responses to added fertilizer. This program was conducted and coordinated with the Tennessee Valley Authority (TVA) fertilizer demonstration program conducted by the Extension soils specialists: Leonard Ladd, Gene Gresham, Merle Schwitzer, Lloyd Davis, Reinder Mesdag and Edward Williamson.

The staff position eliminated in late 1963 was replaced with a field technician in 1964, making it possible to make better use of professional time. This position was filled first by Dale Heesch in 1965 and then by Robert Nettleton in 1969.

The field trials were more closely tied to the TVA fertilizer demonstration program conducted in succession by Extension soils specialists Edward Lagin, Earl Adams, Robert Schoper and Jim Gerwing. Without their help, little would have been accomplished with the field trials.

The field trials resulted in a better knowledge of soil fertility and soil management for many areas of the state and a greatly improved soil fertility evaluation (soil testing) service.

After Gelderman became manager of the laboratory in 1972, the Soil Testing Laboratory, the Extension soils specialist and the Experiment Station project worked together to have a soil fertility program in South Dakota. The research was directed toward solving everyday soil fertility management problems and in support of the Soil Testing Laboratory. A continual program of soil-test fertilizer response calibration is necessary for the Soil Testing Laboratory to continue giving good reliable recommendations to farmers.

FERTILIZER IN SOUTH DAKOTA

The following information was contained in the notes compiled by E. M. White in 1976 from the Bicentennial Benchmark Publication.

E. M. White

Soil testing procedures have been improved by research on yield responses from different fertilizers and their rates of application on

specific kinds of soil. Yield responses to fertilization have varied with the kind of soil. Recommendations for fertilizer from soil testing results are now based on the kind of soil, the area of the state where the sample was collected, and upon the previous cropping history of the field. Nitrogen fertilization rates also have been found to depend upon the quantity of nitrates in the subsoil as well as in the surface layer (Carson).



Soil Testing Laboratory in 1963.

Phosphorus was the first fertilizer recommended in the early 1900s when incomes from crops could be increased 30 percent by applying phosphate to soils at Brookings. At that time added nitrogen and potassium had little effect on yields. Since that time, crops have removed sufficient amounts of these elements so that they are now needed for maximum yields. As more crops are harvested and removed from the soil, additional fertilizer elements probably will have to be applied to keep pace with their removal. The use of nitrogen fertilizer, placed with phosphorus, has increased the utilization of fertilizer phosphorus by crops as much as 100 percent. Band placement of phosphorus has been proven to be 30 to 70 percent more efficient than broadcasting for small grains (Carson, Fine).

Crops in 1910 removed approximately 13 million pounds of nitrogen, 28 million pounds of phosphorus, and 34 million pounds of potassium from South Dakota soils. At that time the total value of the elements removed was about \$30 million. The fertilizer loss in crops has become economically more significant because more needs to be replaced for maximum yields. The amounts removed in grain crops from 1963 to 1973 is much larger than in 1910 when less grain was harvested. Return of phosphorus to the soil by fertilization nearly equals the amount removed in the grain crops. In the future additional amounts of nitrogen, phosphorus, potassium, as well as new fertilizer materials probably will be needed. From 1950 to 1975, a limited number of soils have been found which need iron, zinc, sulfur,

and boron fertilization for maximum crop yields.

Yields from crops fertilized with liquid or dry solid fertilizers were comparable provided the amounts of fertilizer elements applied were the same. Organic fertilizers did not increase yields in proportion to the amount of organic matter they contained. They did increase yields proportional to the amount of fertilizer elements they contained (Shubeck).

The Soil Testing Laboratory from 1950 to 1980 tested more than 239,000 soil samples sent in by farmers and about 57,000 soil samples collected in research studies. In addition, about 23,000 plant samples and 1,100 water samples were analyzed during this 30-year period. The number of samples varied from year to year partly because government incentive payments required a soil test some years but not others. The importance of the soil testing program to South Dakota Agriculture is dramatically portrayed in Chapter XXXVII where the yearly tonnage of commercial fertilizer sold in South Dakota is given.

Number Of Soil Samples Analyzed By Soil Testing Laboratory

Year	Farmer	Research
1950	2200	
1951	1270	816
1952	1740	1,260
1953	1950	1,150
1954	2871	1,129
1955	2970	330
1956	7604	-
1957	6230	770
1958	4900	2,100
1959	4750	250
1960	3800	200
1961	5400	600
1962	6800	1,200
1963	8000	-
1964	9000	800
1965	10,000	950
1966	11,000	1,000
1967	13,000	1,000
1968	12,000	1,000
1969	9000	1,800
1970	8500	1,350
1971	7159	2,700
1972	5894	2,620
1973	1600	1,219
1974	5280	3,734
1975	12,080	3,642
1976	20,435	3,344
1977	18,010	3,238
1978	12,040	3,861
1979	10,079	5,057
1980	13,998	9,847
Total	239,560	56,947

CHAPTER XXIX IRRIGATION

Irrigation attracted the attention of the first agriculturist at Dakota Agricultural College. In 1891, shortly after he became director of the Agricultural Experiment Station, Luther Foster and irrigator Chas A. Duncan wrote: "The subject of irrigation is of great importance to people of South Dakota especially those . . . living in the James River Valley" (Bul 28).

Water had been obtained in abundance from wells drilled into the "great artesian basin", but many questions arose. "Would it pay to drill a well? How much water was needed per acre? How could it be distributed? When should irrigation water be applied and how much did certain crops require? Would artesian water injure the crops?" (Bul 28).

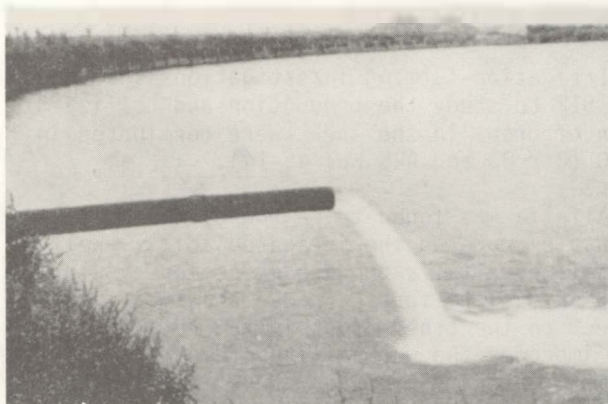
Foster and Duncan estimated the cost of wells that would produce a flow of 500 to 3,000 gallons per minute to be \$2,000 to \$5,000 and estimated that water rights from such wells would be worth \$2,000 to \$12,000 (Bul 28).

They said that the amount of water needed would vary with differences in soils, crops and annual rainfall, but estimated that a well with a flowing capacity of 2,000 gallons per minute would furnish enough water for a section of land (Bul 28).

Their diagrams for water distribution showed a reservoir and a main ditch along the highest area in the field. Lateral ditches extending at an angle down the slope were connected to the main ditch with winged water gates built with 2-inch planks. They stated that a flow of 2,000 gallons per minute could be handled with a ditch 5 feet wide, 1 1/2 feet deep and a fall of 4 feet per mile (Bul 28).

They reported results obtained in 1890 by C. A. Duncan at Mellette and by B. S. Langrange, a "government" employee at Aberdeen and Huron. Work at Huron was "under the local management of A. W. Wilmarth". They also included a report from H. S. Riggs, an irrigator near Frankfort (Bul 28).

Then in 1895, the Experiment Station entered into an agreement with the Spink County Land and Irrigation Company to conduct investigations on irrigation on the Hunter-Salzer Farm near Mellette. The farm had an artesian well, a 5-acre reservoir and over 5 miles of ditches. About 20 acres were planted to many kinds of garden, field and forage crops (Bul 52).



Reservoir on Huner-Salzer Farm in 1890s.



Irrigation ditch--Hunter-Salzer Farm in 1890s.

With passage of the Reclamation Act by the U.S. Congress in 1902, the Bureau of Reclamation was created in the U.S. Department of Interior. The new bureau had the responsibility for planning and developing of available water resources and for their utilization for irrigation. Survey work began in 1903 for construction of Orman Dam on the Belle Fourche River near Belle Fourche.

NEWELL FIELD STATION J. J. Bonnemann

The Belle Fourche Field Station (later named Newell Field Station) was established in 1906, primarily to study irrigation problems. However, only dryland investigations were conducted until after the Orman Dam was completed in 1911.

Irrigation investigations began in 1912 when water became available from the Belle Fourche Irrigation District. Experimentation was carried on by the USDA for over 60 years, however, J. J. Bonnemann, agronomist from SDSC, was located at the station from July 1,

1951 to August 30, 1961. W. E. McMurphy was there from 1962 to 1964; J. T. Nichols from 1964 to 1969; and J. R. Johnson from 1966 to 1969.

Irrigation-farming investigations initiated in 1912 to study the production and utilization of crops in the area, were terminated in 1950 (Cir 83 and ARS Bul 45-14).

Alfalfa was found to be one of the most valuable crops on the irrigated soils. Well fertilized alfalfa produced excellent yields of high quality forage, had a beneficial effect on the other crops in the rotations, and improved the workability of the clay soils. Contrary to other crops, alfalfa produced well over a considerable period of continuous cropping as long as fertility was maintained (Cir 83).

Sugar beets was a profitable crop, but received less benefit from alfalfa in the rotation than any other crop. Beets immediately after alfalfa yielded less than when following small grain or potatoes. This was due to the greater prevalence of sugar beet seedling diseases and other problems of stand establishment when the beets followed alfalfa.

Sweetclover was well adapted for use in 2- and 3-year rotations. It exerted beneficial effect on the tilth of the clay soil and made good pasture for sheep.

Corn Production

An off-station research program was conducted on one of three Butte County farms each year from 1950 to 1954. The objectives were to study the value of nitrogen and phosphorus fertilizer on the production of corn grain and silage grown under irrigation (Cir 120).

An application of nitrogen increased grain yield and protein content on about two-thirds of the fields. A rate of 50 to 60 pounds per acre was usually sufficient. An application of phosphorus increased yields on about one-third of the fields, but yield increases were small--3 to 10 bushels (Cir 120).

An increase in plant population for 12,000 to 20,000 plants per acre was accompanied by an increase in yield of both grain and silage. The response to fertilizer was greater from higher plant populations and vice versa.

MISSOURI BASIN PROGRAM

In 1944 the U.S. Congress authorized a comprehensive program for flood control and water resource development of the Missouri River basin. It embraced a system of more than 100 dams and reservoirs on the Missouri

and some tributaries. Missouri River dams in South Dakota were Gavins Point, Fort Randall, Big Bend and Oahe.

The program included plans for irrigating 2 million acres in the James River Valley from the reservoir created by the Oahe Dam. It was planned that water would be transported through an open ditch from a point north of Pierre to a reservoir north of Blunt. Another ditch would transport the water to a point north of Miller. At that point smaller ditches would carry water to a reservoir near Cresbard and to Lake Byron. An area west of the James River in Spink and southern Brown counties would be irrigated from the reservoir at Cresbard. Return flow from this area and water from Lake Byron would be used to irrigate an area east of the James River in southern Spink County.

AGRONOMY PERSONNEL

Staff Members

L. O. Fine*	1950-1954
R. E. Campbell (USDA)	1950-1954
F. Wiersma	1953-1955
H. M. Vance (USDA)	1955-1959
Z. F. Lund (USDA)	1961-1964
P. D. Evenson	1961-
D. G. Shannon	1971-1974
P. D. Weeldreyer	1974-1978

Graduate Students

Ralph Campbell	M.S.	** 1954
Walter Zich	M.S.	1955-1957
Norman E. Zischke	M.S.	9/1/61-6/5/63
C. Greg Carlson	M.S.	1971-1972
Loyd R. Stone	Ph.D.	1/7/69-6/30/73
Dennis Shannon	M.S.	** 1973
C. Greg Carlson	Ph.D.	1974-1977
Stanley E. Papendick	M.S.	1976-1978
Paul D. Weeldreyer	M.S.	** 1978

*Project leader,

**Full-time assistant while doing graduate work.

HURON AND REDFIELD DEVELOPMENT FARMS

The Bureau of Reclamation established a soil testing laboratory at SDSC in 1947 and leased land for the Huron and Redfield Development Farms. Water was available from the James River for both farms.

The Experiment Station, in cooperation with the Agricultural Research Service of the USDA, initiated irrigation research at both farms in 1948. The Huron Development Farm was discontinued in 1954 and the USDA discontinued its efforts at the Redfield Development Farm,

later called the Redfield Irrigation Station, in 1959.

Pastures at Huron

From 1948 to 1952, seven different pastures were grazed by Hereford steers. The pastures included native grass with and without fertilization and alfalfa-smooth brome grass on dryland and a grass mixture and two alfalfa-grass mixtures on irrigation (Cir 107).

Hay and Grass Seed Production

Also at Huron, eight grasses were planted in the spring of 1949 on irrigated and non-irrigated land, and nine were planted in spring and fall of 1950 under irrigation. Several rates of nitrogen fertilizer were applied to the 1950 seedings in 1951 and 1952 (Cir 107).

Crop Performance Testing

At Redfield, Standard Small Grain Variety Tests and Corn Performance Tests were conducted under irrigation and sometimes on dryland almost continuously from the time the station was opened. Forage grasses and alfalfa strains were compared under irrigation from time to time. Eight grasses were planted in 1949-1950 and compared for hay and seed yields. Likewise, in 1950 five alfalfa varieties were compared with a like number of alfalfa strains under both dryland and irrigated conditions (Cir 107).

Sugar Beet Management

An experiment was initiated at Redfield in 1952 with various nitrogen, phosphorus and moisture levels to study the effect upon sugar beet physiology and growth (Cir 107). These studies were discontinued during the 1960s when the U & I Sugar Beet processing plant at Belle Fourche was closed.

Horticultural Crops

About 20 potato varieties and numerous vegetables were grown at Redfield during the first years at the station (Cir 107). The potato offered a good potential for high return per acre if adequate crop care and proper soil and irrigation management were practiced. Under irrigation the yields of five varieties ranged from 171 to 217 bushels per acre in 1953, but production doubled when adequate fertilizer was used. Because of their limited root system, they required a high level of available soil nutrients and moisture throughout the growing season (Bul 512).

Potatoes were discontinued but garden crops were grown on a number of occasions. In

several experiments different irrigation techniques were compared for use in home gardens.

Soybean Management

The first soybean experiment was conducted at Redfield in 1952. Tests were made to determine yield potentials of soybeans as affected by various moisture regimes and to measure the effects of several row spacings and plant populations on yield. Beans were planted at 2-, 3- and 4-inch intervals in 9-, 18- and 36-inch rows (Cir 107).

Three varieties were planted in 18- and 36-inch rows in 1953. Variety differences were far outweighed by the effects of changing row spacings from 36 to 18 inches. During the high rainfall season, soybeans produced 30-bushel yields on dryland, and yield was not improved materially by irrigation (Bul 517).

Corn Fertilization and Management

Because of the economic importance of corn and the probable increased emphasis on the crop under irrigation, major attention was given to it at Redfield. The first experiments ranged from nitrogen fertility trials to extensive experiments combining methods of planting, rate of planting, fertility and moisture (Cir 107).

In 1949 a 2-year crop rotation of corn-wheat and a 4-year rotation of corn-wheat-alfalfa-alfalfa were established on both dryland and irrigation. In each rotation, each crop was grown on a separate block that included several plots. Six basic fertilizer treatments were applied to each rotation (Cir 107). Average yields were obtained for 7 years from 1949 to 1955 (Bul 517).

In the 4-year rotation, corn responded to nitrogen fertilizer during the first 2 years, but the alfalfa provided most of the nitrogen needed after 1951. Wheat showed a marked response to fertilizer throughout the period. In the 2-year rotation, both crops produced higher yields when fertilized (Bul 517).

Irrigation tripled corn yields, more than doubled alfalfa production, but increased wheat yields only 22%. Wheat yields, however, were increased more on fertilized plots than unfertilized (Bul 517).

In another study, ten fertilizer treatments containing varying amounts of nitrogen and phosphorus were applied from 1953 to 1962 in a 3-year rotation of barley-corn-corn and a 5-year rotation of barley-alfalfa-alfalfa-corn-corn (Bul 416).

In the 3-year rotation, crop yields were not affected by the application of phosphorus,

but yields of both crops were increased significantly by nitrogen. In the 5-year rotation, corn yield was not affected by the use of fertilizer, while barley production was increased slightly by both fertilizers. Alfalfa yield was increased by phosphorus and reduced by nitrogen application (Bul 416).

Because of higher crop yields, the net cash returns from all fertilizer treatments in the 3-year rotation, except phosphorus used alone, were higher than from unfertilized plots. The exact opposite was true in the 5-year rotation. Phosphorus alone produced a \$1-per-acre higher net return than the unfertilized, while yield was not increased enough by other treatments to pay for the cost of fertilizer (Bul 416).

In 1955 a study was conducted at Redfield on the distribution of nitrogen needs by corn during the growing season. All the above ground plant parts were harvested on four different dates and analyzed for nitrogen content. Plants under irrigation assimilated about 50% more nitrogen than those on dry land. By the time of the first sampling date (August 9), about two-thirds of the total nitrogen for the year had been assimilated. However, a considerable portion of the total nitrogen was taken up in the last few weeks of the growing season, an important factor in getting complete filling of the ears (Bul 517).

Grass Seed Production

Various tame and native grasses were tested at Redfield. In most experiments a combination of row spacings, usually 9, 18 and 36 inches apart, and fertilizer applications were superimposed to measure the effect of fertility and row spacing with cultivation under irrigation (Bul 517).

Performances of the higher producing tame grasses were nearly the same from all row spacings and fertilizer treatments for the first 2 years. However, in the second and third years after planting, nitrogen deficiency became more and more acute, and seed yields dropped with 9-inch spacing and solid seedings on unfertilized plots.

Water Management

Experiments were established at Redfield during 1951 to study the use of moisture by various crops, infiltration rates and management of irrigation water. One experiment involved a study of the consumptive use of water by corn, alfalfa, wheat, sugar beets, potatoes and dry beans. Another included studies of infiltration rates, rates of advance, irrigation efficiencies and proper streams of water on various widths of rows and borders.

A third compared different sizes of irrigation sprinkler nozzles (Cir 107).

Soil Moisture Depletion

Two agricultural engineers, L. J. Erie and N. A. Dimick, reported in 1954 that nearly 90% of the moisture used by irrigated crops at Redfield was extracted from the top 3 feet of soil, approximately 75% from the first 2 feet and over 50% from the top foot. They suggested that the irrigator apply only enough water to bring the top 3 feet to field capacity in most cases (Cir 104).

Each crop had a critical period for moisture--usually at blossoming time. At that time abundant moisture must be available to the plant for high production (Cir 104).

Drainage

During the mid-1960s, W. D. Lembke of the Agricultural Engineering Department planted 38 grain sorghum varieties on a drainage plot at Redfield to observe the effect of high water table during the period that the sorghum was heading (Cir 170).

He also measured the concentration of salts in the drainage tiles and observed that there was an increase in salts as irrigation water passed through the soil profile (Cir 170).

OTHER RESEARCH LOCATIONS

Included in the 1944 water resource development program were the Shadehill Dam on the Grand River and the Angostora Dam on the Cheyenne.

Early in the 1950s the Shadehill Irrigation Farm was established near Lemmon. The farm was maintained for 8 years. Irrigation research was initiated on private farms near the Angostora Dam south of Hot Springs in 1955 and in Yankton County during 1956.

Numerous intensive experiments were conducted on water, crop and soil management practices for optimum production of such row crops as corn, sorghum, sugar beets, potatoes and soybeans. It was felt that they had a greater potential response to irrigation than small grains (Bul 517).

Corn Production

Experiments were conducted on the Angostora Irrigation Project and in Yankton County on private farms to study aspects of corn production such as plant population, choice of hybrids, irrigation regimes and fertilizer practices (Bul 517).

At Angostora, five irrigation schedules and six fertility treatments were applied on three soil types. Poor yields were obtained and there was little response to fertilizer when irrigation was neglected during the tasseling to silking stage of growth. However, when irrigation water was added at the time that soil moisture content in the root zone reached the midpoint between field capacity and the wilting point, good corn yields were obtained when adequate nitrogen was applied. The optimum amount of nitrogen varied with soil type (Bul 517).

In a 1956 experiment at Angostora several rates of nitrogen were applied. The additional yield from 80 pounds of nitrogen per acre was economically feasible with a return of nearly \$2 worth of corn for \$1 invested in fertilizer. The next increment of 40 pounds also returned more than the cost (Bul 517).

Results from a 1956 experiment at Yankton were similar to those obtained at Angostora in 1955. Corn yields with the best fertility practice were 40 bushels higher when adequate moisture was provided during tasseling to silking than when irrigation was restricted during that period (Bul 517).

Experiments at both locations in 1956 were correlated with the Redfield study of nitrogen assimilation during the growing period. Though the total uptake of nitrogen varied widely among the four soils, the time distribution of nitrogen uptake was very similar. By August 1, slightly less than half of the total nitrogen for the year had been assimilated from Farland sandy loam and Orman clay,

but 80% of it had been taken up from the Gap silt loam (Bul 517).

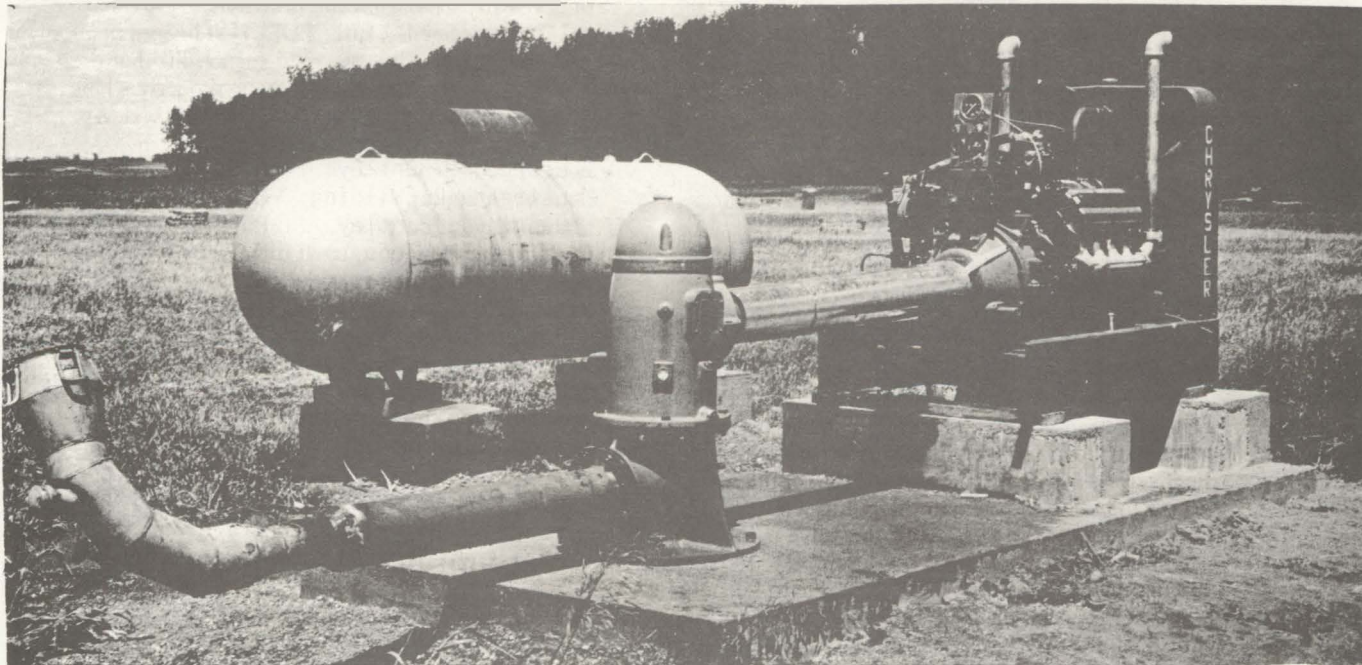
Experiments involving corn hybrids of various maturities in combination with several stand densities, fertilizer practices and methods of planting were conducted in Yankton, Spink and Brookings counties for several years (Bul 517).

Raising the plant population from 16,000 to 19,000 plants per acre increased yield by 10 or more bushels per acre; whereas, the next 3,000 increase in plant population raised yield only about 5 bushels with the same fertility and water management (Bul 517).

The results indicated that a plant population of 18,000 to 20,000 generally gave near maximum yields. Hybrids that matured 4 to 5 days later than those used on dryland could usually be used with irrigation. Adequate soil moisture was essential between tasseling and silk-browning to get maximum production. Nitrogen uptake continued until denting or later and the supply must be adequate all through the growing season. Alfalfa in the rotation increased the available nitrogen about 60 pounds per acre for 2 years of corn (Bul 517).

Agricultural Engineering Farm

The Agricultural Engineering Farm was established on the Sioux River near Brookings in 1956 for the primary purpose of conducting irrigation research. Emphasis was placed on studies of performance efficiency and crop adaptability of wells, pumps and various irrigation sprinkler systems.



Irrigation pump used during the 1970s.

CHAPTER XXX SOIL SURVEY AND PHYSICS

In 1912, Dr. A. N. Hume wrote: "South Dakota soils are not all equally fertile. They do not have equal ability to produce crops even with equal amounts of rain. They vary in physical condition . . . and food content . . . and do not respond equally well to the same kind of treatment (Bul 139).

"South Dakota must provide for a statewide study of her soil and crop conditions. The plan must include every county, every great soil type, and at least every farm . . . How will one find out about the soils of South Dakota? Send a man out to make examination and report. What will you do with the report? Make a plain statement of it, and map it perhaps, and publish it" (Bul 139).

A year later the South Dakota Corn and Grain Growers Association passed a resolution to ask "the legislature to appropriate \$15,000 per annum for the purpose of demanding that our state Experiment Station make more adequate study of soils" (JW-9).

And in 1918, the association again voted to request the legislature for a state soils survey (JW-11). In 1919 the legislative committee, appointed to attempt to secure a legislature appropriation for soils survey work, was influential in securing an appropriation for \$10,000 per year to be used for that purpose (JW-12).

A. N. Hume was named Director of Soil Survey. Immediately after the appropriation was secured, arrangements were made with the U.S. Bureau of Soils for federal assistance and on July 11, 1919, W. I. Watkins, a federal employee, started on soil survey. J. G. Hutton directed the work from the Experiment Station and employed two students (JW-12).



J.G.Hutton examining a soil sod profile in 1920s.

It might be interesting to note that W. H. Pierre, a long-time staff member and later head of the Department of Agronomy at Iowa State University, served as an Assistant in Agronomy on a Soil Survey team in 1921 (Brage).

The work was suspended during the depression. However, it was rejuvenated when Fred-erick C. Westin was hired on July 1, 1947 to head the program. The following year Gerhard- B. Lee and A. J. Klingehoets were added to the soil survey staff.

SURVEY PERSONNEL

Staff Members

J. G. Hutton*	1919-1939
W. I. Watkins	1919- ?
Dr. F. C. Westin*	7/1/47-5/11/81
A. J. Klingelhoets	1948- ?
G. B. Lee	1948- ?
W. C. Moldenhauer	1949-1954
James Anderson	1949- ?
Dr. G. J. Buntley	7/1950-6/1968
Dr. F. E. Shubeck	8/1/51-1955?
Dr. E. M. White	6/1954-1969
L. P. Wilding	1/6/56-1/9/59
B. G. Bonestell	1956-1959
R. Matheny	1959- ?
E. A. Monnens	1961-
Lionel Blogg	1964- ?
Dr. C. Frazee	1969-1974
Dr. D. D. Malo	3/15/75-
T. J. Martin	1978-
Gary L. Lemme	8/15/81-

Graduate Students

George J. Buntley	M.S.	6/49-6/50
Lawrence P. Wilding	M.S.	** 1959
George J. Buntley	Ph.D.	** 1963
Earl A. Monnens	M.S.	** 1964
M. Everett McNamara	M.S.	-1963
Robert D. Heil	M.S.	** 1965
Ronald A. Torkelson	M.S.	9/65-10/68
Lawrence A. Benson	M.S.	1971-1973
Robert D. Heil	Ph.D.	1972
Gary L. Lemme	M.S.	1972-1975
Michael J. Archer	--	1974-1975
James L. Halbeisen	M.S.	-1975
Robert D. Nielsen	M.S.	8/78-5/80

* Project leader; **Full-time assistant while doing graduate work.

SOIL SURVEY ACTIVITIES

Initially the activities were limited to the mapping of the soils in various counties of the state and the publication of County Soil Survey Reports. However, activities were broadened to include interpretations of the information.

Soil Survey Reports

Under Hutton's supervision, reconnaissance soil surveys were published for several counties.



F. C. Westin studying soils of Badlands.

Under Westin's supervision, soil surveys were conducted in cooperation with the Soil Conservation Service and the Bureau of Plant

Industry, Soils and Agricultural Engineering of the USDA. Soil surveys were initiated in Spink and Brookings counties in 1947.

Spink County was selected because it was in the area of the proposed Oahe irrigation project. A survey crew, which included Westin, James Anderson, William Modenhauer and George J. Buntley, lived at Redfield during the week in the summertime. They worked 5 to 6 days a week.

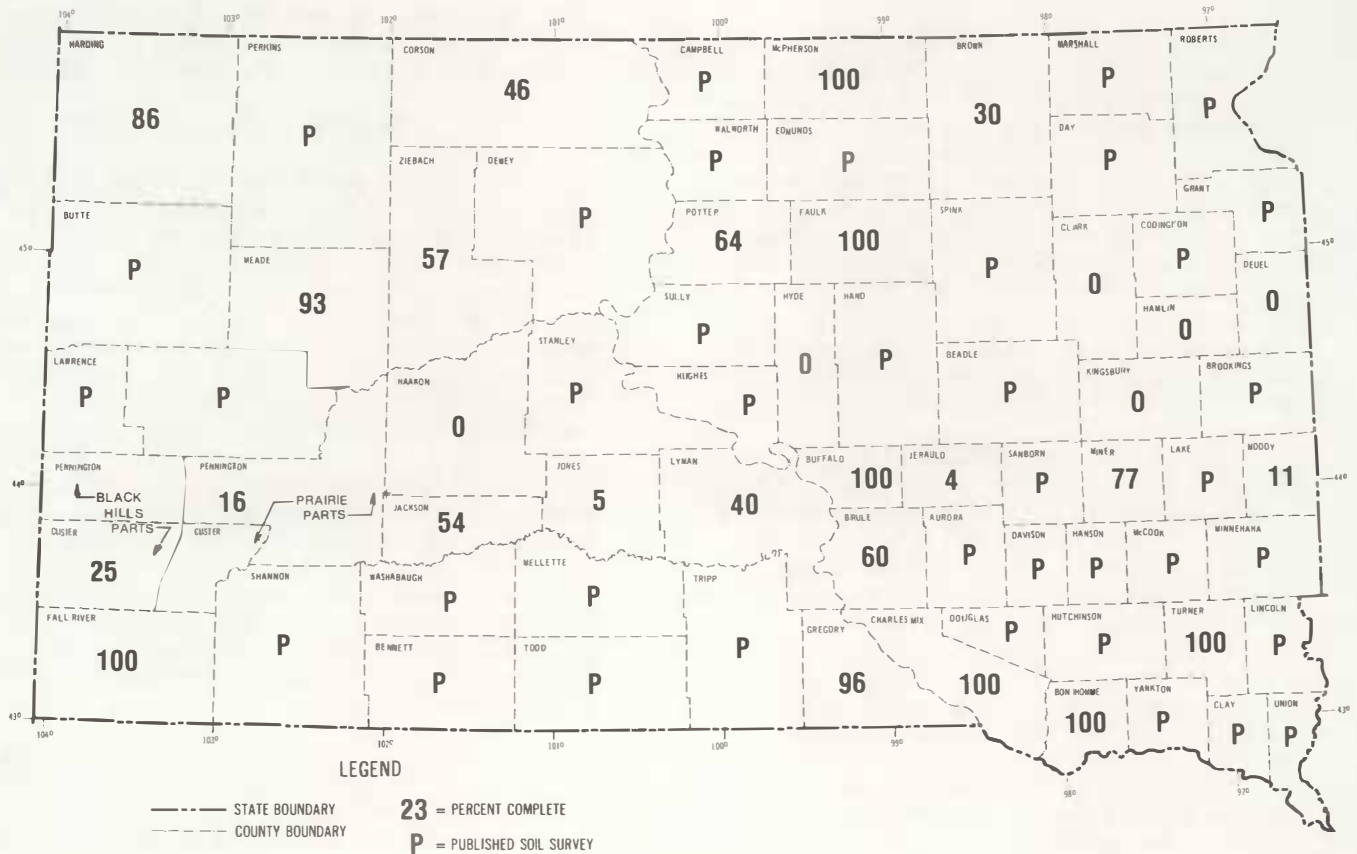
Brookings was selected because of its proximity to SDSC. The survey crew worked a



A.J. Klingelhoets and L.L. Ladd study soil map.

SOUTH DAKOTA SOIL SURVEYS

OCTOBER 1, 1981



day at a time whenever weather permitted, during the late fall, winter and early spring. Soil Survey Reports were published in 1954 for Spink County and in 1959 for Brookings.

W. I. Watkins returned to serve as crew chief for the reconnaissance soil survey of Potter County. A report was published in 1955.

Except for the map obtained from D. D. Malo, the following information was contained in the department's bicentennial benchmark publication assembled by E. M. White in 1976.

E. M. White

Soil maps were prepared and published cooperatively with the Soil Conservation Service, Bureau of Indian Affairs, and the Research Branch of the State Highway Department. Each soil survey report contained a map and a text in which the soils were interpreted for best land use, for engineering purposes and for forest, recreational and wetland management. Estimated yields for different crops and for range were also given for each soil. County reports were published for 36 counties from 1950 to 1980. The mapping for 23 additional counties is nearly completed or in progress, and no survey has been conducted in six counties.

Soil Genesis

A soil's potential can better be evaluated if the chemical and physical changes in the soil parent material that are caused by soil formation processes are understood. With this information, future changes can be predicted. The genesis of forested and prairie soils in the Black Hills were studied. These studies on soils with different parent materials showed that soil development is dependent on climate and the vegetation. All of the Black Hills soils could be and possibly have been forested although soils at lower elevations probably could be used more profitably for range rather than forest production.

Soil Structure

Claypan soils with high sodium contents gradually lose the sodium if water drains through the soil. Chemical and physical changes, and the relationship between the two were studied so that the sodium-rich soils which respond to remedial cultural practices could be identified. When sodium was lost and water moved downward through the soil, clay particles in the claypan moved downward through the soil to coat surfaces and fill small pores of soil structure units. The soil became less permeable by this plugging action (Westin and White).

Differences between surfaces and interiors of structural units of a low-sodium soil were studied to better understand the clay movement process and the effect this movement had on plant roots. It was learned that soil in the structure surfaces contained more organic matter and nitrogen than the interiors which were less accessible to roots (Heil and Buntley).

Well- and moderately-well-drained soils in the northern part of eastern South Dakota contained more organic matter and nitrogen and had a darker color than soils in the southern part (Wilding, Buntley and Westin). Phosphorus in the northern part was associated more with aluminum, calcium, and organic matter and less with iron than in the southern part. Analyses of chemical and physical properties of 16 soils of eastern South Dakota were related to the amount of available phosphorus in the soils (Westin).

Land Value

Studies with the State Department of Revenue on the relationship between soil productivity and land values resulted in the development and publication of land value guides for 41 of the 67 counties. Mimeographed guides for the remaining counties were given to state land equalization officers. All land sales in the state were incorporated into a formula along with soil productivity to provide the assessors and all others who wished to use it with an easy-to-use method of utilizing soil surveys to evaluate land (Westin).

Use of ERTS Imagery

In 1973 Earth Resources Technical Service (ERTS) from Sioux Falls was used as a field base map for a soils and land use map of Pennington County. Using land-sales data and the general soil map, a land-value map of Pennington County was prepared. This map was encoded into the computer and a value for each quarter section of land printed. This was used for the reappraisal of the land in Pennington County (Frazee).

Research was done cooperatively with the Remote Sensing Institute and NASA to utilize satellite and aircraft imagery in the soil survey program. During 1975 and 1976 technical papers were presented at three ERTS symposia, one photogrammetry symposium, and one international ERTS symposium held in Germany. The papers were published in symposia proceedings.

Two South Dakota soil maps and one county map were published on ERTS satellite imagery. One state-wide map was used to extend land-value data and the others to extend soil-test

results since 1952 for organic matter, phosphorus, potassium, and pH. The multispectral and temporal characteristics of the ERTS map, when used as a base, allowed the user to interpret many of the characteristics of soil and land. A brief description accompanied each map explaining the multispectral and temporal advantages of the ERTS imagery.

It was estimated that 30,000 conventional air photos costing \$250,000 would be needed to construct a state mosaic of South Dakota. The ERTS mosaic required 20 scenes, each costing about \$2.00 (Westin and Frazee).

SOIL PHYSICS

Soil physics was added to the list of activities in the Agronomy Department in 1955. After Maurice L. Horton left the project to join the Water Resources Institute in 1973, activities were suspended for 2 or 3 years because of a lack of funds.

Personnel

Staff Members

Dr. J. R. Runkles *	1955-1963
Dr. M. L. Horton *	9/64-3/73
B. S. Sandhu	1970-1972
Dr. R. A. Kohl *	3/75-

Graduate Students

Clinton D. Stoner	M.S.	7/56-6/60
Robert I. Papendick	Ph.D.	-1963

Jon Bartholic	Ph.D.	8/1/59-6/1/64
Donald G. Moore	Ph.D.	1969-1972
Ronald R. Schnabel	M.S.	1975-1977

*Project leader

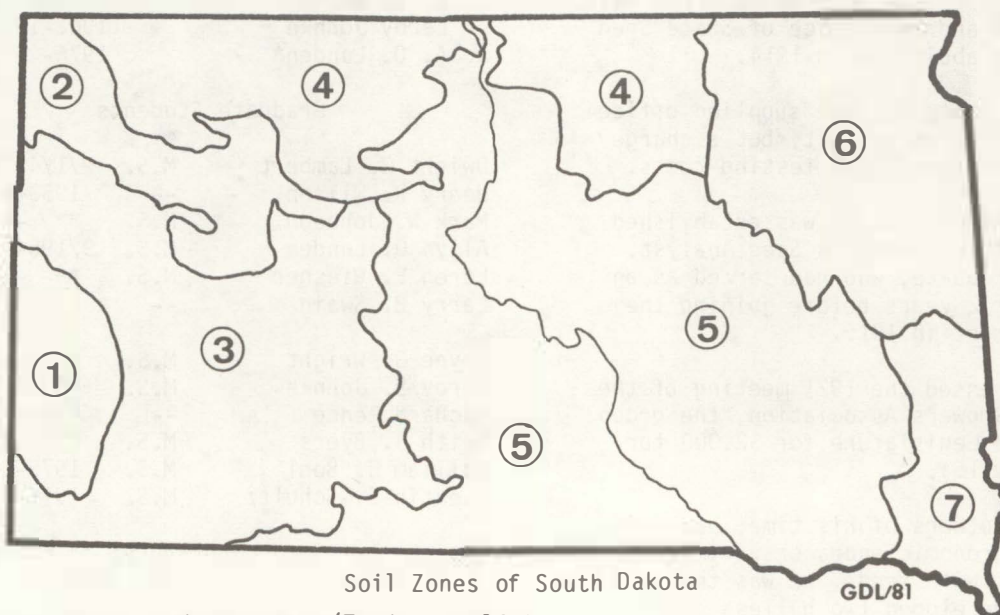
Soil Physics Activities In 1970s R. A. Kohl

During the interim period from 1972 to 1975, M. L. Horton taught the undergraduate and graduate soil physics courses in addition to directing research activities in the Water Resources Institute.

Robert A. Kohl was appointed to the Plant Science staff as soil physicist on March 1, 1975. He assumed the responsibility of teaching the two soil physics courses and in 1978, the soil conservation course.

Research activities began with a study of the effects of deep plowing (to 2 feet) a clay-pan soil near Redfield on corn rooting distributions.

Root distributions and water uptake patterns were then studied on glacial till soils in eastern South Dakota to obtain information on water holding capacities and efficient water utilization. Data were also gathered on crop phenological development as a function of climatic variables to predict crop cover as the growing season progressed. These data were needed to improve erosion loss estimates with the universal soil loss equation.

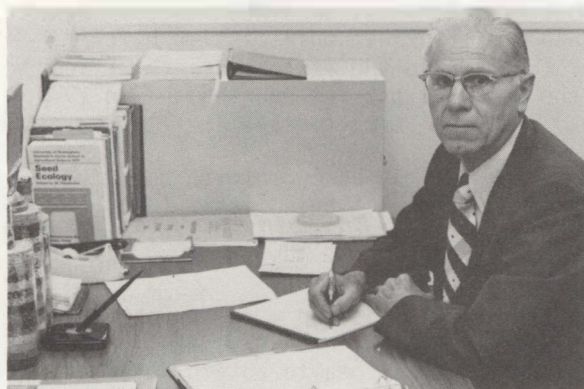


- | | |
|--|---------------------------------------|
| 1. Cool, Moist Forest (Typic Boralfs) | 6. Cool, Moist Prairie (Udic Borolls) |
| 2. Cool, Very Dry Plain (Aridic Borolls) | 7. Warm, Moist Prairie (Udic Ustolls) |
| 3. Warm, Very Dry Plain (Aridic Ustolls) | |
| 4. Cool, Dry Plain (Typic Borolls) | |
| 5. Warm, Dry Plain (Typic Ustolls) | |

CHAPTER XXXI STATE SEED LABORATORY

R. C. KINCH

The Association of Official Seed Analysts of North America was organized in 1908 at Washington, D.C., by representatives of several colleges of agriculture, the USDA and the Canada Department of Agriculture. South Dakota became a member of the Association but the first meeting attended by a South Dakota representative was in 1916 when Mathew Fowlds attended the St. Paul, Minnesota, meeting.



R. C. Kinch, head of Laboratory--1947-1976.

The earliest record of seed testing in South Dakota dates back to 1912 when the legislature established a State Seed Department. Irwin S. Oakland was appointed State Seed Commissioner with an office at South Dakota State College. Problems were encountered with this arrangement and the office of State Seed Commissioner was abolished in 1914.

South Dakota State College supplied office space for seed testing activity but a charge had to be made to cover seed testing costs.

The State Seed Laboratory was established at SDSC with Mathew Fowlds as Seed Analyst. He was a 1913 graduate, who had served as an Entomologist for 2 years before joining the Agronomy Department in 1915.

After he addressed the 1921 meeting of the Corn and Grain Growers Association, the group voted to ask the Legislature for \$2,000 for seed testing (JW-15).

Fowlds, like others of his time, participated in many agronomic endeavors. In addition to his work with seeds, he was the weed taxonomist; he developed two hullless oats varieties and worked with forage crops.

In 1935 the Legislature again established the position of State Seed Commissioner to supervise seed analysis, seed certification

and regulation. R. W. Vance was appointed to the position and was to be given an office at South Dakota State College. The arrangement did not work out well.

The members of the South Dakota Crop Improvement Association expressed considerable dissatisfaction at their annual meeting in Huron on September 14, 1938. The fact that the Seed Commissioner was a political appointee seemed to be the basis for the dissatisfaction (JW-42).

The office of the Seed Commissioner was abolished in 1939. The seed certification and seed regulation activities were transferred to the Department of Agriculture at Pierre and the seed testing activity was resumed by the Agronomy Department.

COLLEGE PERSONNEL

Staff Members

Mathew Fowlds*	1921-1939
E. L. Erickson*	1939-1946
N. G. Patterson	1944-1947
R. C. Kinch*	1947-1976
Raymond Walz	1949-1951
M. W. Johnson	8/1951-1957
W. G. Wright	1956-1962
L. E. Wiesner	1962-1966
Leroy Johnke	1968-1973
A. O. Lunden*	1976-

Graduate Students

Dwight G. Lambert	M.S.	9/1/47-6/1/49
Henry R. Wilson	--	1953-1954
Mark W. Johnson	M.S.	** -1957
Allyn O. Lunden	M.S.	9/1954-6/1956
Loren E. Wiesner	M.S.	** -1963
Larry B. Swain	--	1964-1965
Wayne G. Wright	M.S.	** -1965
Leroy E. Johnke	M.S.	** -1973
Richard Pence	--	1967-
Keith J. Byers	M.S.	1971-1973
William H. Bohl	M.S.	1973-1975
Quentin E. Schultz	M.S.	1974-1976

* Director of Seed Laboratory; ** Full-time staff while doing graduate work.

Many students conducted purity and germination tests, on a part-time basis, while attending college. Lyle A. Derscheid, for example, worked under E. L. Erickson for 3 1/2 years. During his junior and senior years in college,

he supervised students performing purity and germination tests. Leonard L. Schrader and Charles J. Wilbur were two of them. Schrader became the first Extension Weed Specialist and Wilbur established the Wilbur Seed Company in Miller during 1949.

In later years as many as 20 students were hired part-time each year. This practice provided for a very flexible and capable work force. During the winter and spring when the seed testing load was heavy, more students were hired. It provided a learning experience and income for students, and extremely rapid and accurate seed testing services for customers of the laboratory.

NEW REGIME

Matthew Fowlds retired in 1939 and Elmer L. Erickson, who had been with the Iowa State Seed Laboratory, was employed to supervise the seed testing work. He also served as taxonomist, taught seed and weed courses, and was project leader for forage and weed research.

He developed a series of weed seed plates. Holes were punched in cardboard to form receptacles for seeds. Each plate held the seed of 24 weed species. Panes of glass covered each cardboard on front and back. They were held in place by strips of galvanized tin. One series of five plates contained seeds of 120 weed species. Plate VI contained seeds of noxious, secondary noxious and other common weeds.

Erickson was much interested in improving seed testing equipment and devoted much time to developing and perfecting several seed testing aids. A vacuum seed counter was developed for seed laboratory use. It was patented and manufactured by the South Dakota State College Foundation. Likewise an air blast separator, the "South Dakota Blower", was developed to be manufactured and distributed by the Foundation. He gave a paper at the 25th annual meeting of the Association of Official Seed Analysts in 1944 at Columbus, Ohio, on "Design, Construction, Operation, and Performance of the 'South Dakota Blower'."

The demand for seed testing services continued to grow and in 1944 Norman Patterson was employed to supervise under Erickson's direction all seed testing work. College students were employed part-time to do some of the work. The Seed Laboratory was moved from Room 204 in the Administration Building to second floor of the Headhouse of the horticulture greenhouse.

A complete change in administration and supervision of the Seed Laboratory occurred in 1947, both Erickson and Patterson resigned.

Raymond C. Kinch, who had been with the State Seed Laboratory of the Nebraska Department of Agriculture in Lincoln, Nebraska, was employed as Assistant Professor of Agronomy in charge of the Seed Laboratory. He reported on February 1, 1947.



Home of Seed Laboratory from 1945 to 1952.

Erickson, upon resigning, devoted full time to the manufacture and sale of the vacuum seed counter, the "South Dakota Blower" and other seed testing equipment. At this writing (1981) he is continuing that activity with sales of seed testing equipment all over the world.

While the Seed Testing Laboratory was located on the second floor of the Horticulture greenhouse headhouse, more and more seed samples were being sent or brought to the laboratory. Records of these early seed testing activities are not available before the 1945-1946 year.

In 1947 Kinch was vice president of the Association of Official Seed Analysts. However, the president, Dr. G. P. Steinbauer of Orono, Maine, had taken a non-seed position with another university. Consequently, Kinch served as president for the remainder of 1947, and presided at the annual meeting in Richmond, Virginia, then he served the full year of 1948. The annual meeting was at Springfield, Illinois.

The first graduate student in Seed Technology, Dwight W. Lambert, was a 1947 graduate of the University of Nebraska. He received an M.S. degree in 1949 and continued working in the Seed Technology field. He is now in charge of all the Federal seed testing laboratories with his office in the Agricultural Research Center in Beltsville, Maryland.

In 1948 a 4-day seed short course was held for South Dakota seed company personnel. Subjects covered were (1) South Dakota Seed Law requirements; (2) seed testing and labeling

requirements; and (3) identification of crop, common and noxious weed seeds. Also in 1948, a meeting of South Dakota Seedsmen was held to reorganize the South Dakota Trade Association that had ceased to function for the preceding several years.

In 1949 additional teaching responsibilities were given to Kinch. Ray Walz, a 1949 SDSC graduate, was added to the staff to perform some of the supervisory work in the Seed Laboratory.

In 1950, with the assistance of Leonard Schrader, Extension Weed Specialist, and Elmer Sanderson, Extension Agronomist, Kinch wrote the "South Dakota Weed Manual," published by the State Weed Board. It illustrated and described the noxious weeds and 110 of the most common weeds of the state.

New Laboratory

In 1952 the Seed Laboratory moved from the Horticulture headhouse to new quarters built specifically for it in Rooms 240 and 242 on the second floor of the new Agricultural Hall. The new Seed Laboratory more than doubled the working space and provided separate rooms for purity and germination tests and a storage for supplies.



Students (Merle Krier) in foreground running purity tests in 1956.

A Federal program involving the Commodity Credit Corporation with price supports on grass and legume seeds was enacted in the early 1950s which created an unusually heavy demand on the laboratory for purity and germination tests. Some samples had to be tested up to five times to qualify for price support. Then when the seed came out of storage it had to be tested again. Because the laboratory was in more modern quarters, the extra work was handled with very little delay.

Walz resigned in 1951 to take charge of the Montana Seed Laboratory in Bozeman. Mark W. Johnson, a 1951 University of Nebraska graduate, replaced Walz. At that time Kinch was teaching courses in Grain Grading, Weed Control, and Seed Technology. He was also coaching the Crops Judging Team that competed in the Intercollegiate Crops Judging Contests in

connection with the American Royal Show in Kansas City, Missouri, and the International Hay, Grain and Livestock Show in Chicago, Illinois.



Students counting (left) and planting (right) germination tests in 1950.

Johnson supervised the work of the laboratory in the year of 1955-1956 while Kinch took a year of sabbatical leave for advanced study at the University of Nebraska. Allyn Lunden, a 1954 SDSC graduate assistant, assisted with the work. In 1956 Johnson held a 2-week school for seed analysts of the North Central region. Albina Nusil of the Federal Seed Laboratory in Washington, D.C., was the instructor.

Lunden completed work for an M.S. degree in 1956 and moved to the University of Florida where he obtained a Ph.D. degree. Mark Johnson completed work for an M.S. degree in 1957 and left to assume supervision of the New Jersey Seed Laboratory in New Brunswick, New Jersey. Wayne G. Wright, a 1957 SDSC graduate, was employed to replace Johnson and continued until 1962 when he completed the work for an M.S. degree and transferred to weed control work.

CONSOLIDATION OF SEED TESTING

In 1965 arrangements were made with the South Dakota Department of Agriculture in Pierre to regularly make the official seed analyses of samples collected by State seed inspectors in connection with their seed law enforcement work. This brought all seed testing together in the Seed Laboratory; (1) service samples for farmers, seedsmen, elevators, seed stores, and gardeners; (2) certification samples from all fields that had passed the Certification Service field inspection; (3) official samples from the Department of Agriculture; and (4) research tests from research projects of Seed Technology students and other research projects in the Agronomy Department or the entire University.

TETRAZOLIUM TESTING

In 1962 investigation was initiated into a technique for rapid determination of seed

viability. A chemical salt 2,3,5-triphenyl tetrazolium chloride had been reported in seed publications to cause live tissue to turn red. A 0.2% solution of the material produced a colorless solution. When a soaked seed was sectioned to expose the embryo and placed in the solution the live tissue would turn red in 2 to 4 hours. If the embryo was not alive it would not change color. If only parts of the embryo were alive only those live parts turned red. Initial studies indicated that the chemical was very useful in determining the germination potential of dormant range grass seeds that required months of prechilling before germination could take place. The entire test of presoaking, placing the sectioned seeds in the solution and the reading of the results could be completed in about 24 hours.

Loren Wiesner, a 1962 SDSC graduate, replaced Wayne Wright and did his masters research work on range grass seed studies. He found that the tetrazolium test (TZ) gave a viability reading closely approaching the subsequent germination test that required several weeks to complete. With the success of the TZ test with range grasses, the color test was applied to other crop seeds. Good correlations with germination tests were obtained when the test and reading of the test were done properly.

TZ or viability testing continued to expand. More kinds of seeds were tested and a greater number of tests performed. Now it is an integral part of laboratory services and effectively estimates germination potential of seed in a very short period of time for nearly all species of plants including weeds as well as crops.

Loren E. Wiesner completed an M.S. degree in 1963 and remained to continue TZ and range grass seed studies, but left in 1966 to assume supervision of the Seed Laboratory at Montana State University in Bozeman.

Leroy Johnke, a 1967 SDSU graduate, assisted in the laboratory and began graduate studies. Also in 1967 Richard Pence, a Montana State University graduate, came to the laboratory and started graduate studies on wheat quality under a grant from the South Dakota Wheat Commission.

Keith Byers, a 1971 SDSU graduate, took a graduate assistantship and continued studies in TZ and range grass seed testing. He also assisted with coaching of the Intercollegiate Crop Judging team. He graduated in 1973 and was succeeded by William Bohl, a 1973 Montana State University graduate.

The studies with germination testing of

range grass seeds and correlating the quick TZ test with subsequent germination tests that required several weeks to complete led to the preparation of several papers given at the Association of Official Seed Analysts meetings. The South Dakota Laboratory was then recognized as the laboratory giving the most accurate and consistent TZ and germination tests of western wheatgrass seed. Seed companies from all over the Great Plains and western states were sending their western wheatgrass samples to Brookings for tests.

Quentin Schultz, a 1974 SDSU graduate, began additional studies with western wheatgrass seed as his research problem. Bohl completed graduate work in 1975 and Schultz graduated in 1976.

Kinch retired June 30, 1976, after 29 years of work with the South Dakota Seed Testing Services, and related fields of grain grading, crop judging, weed control, and plant and seed identification.

Allyn O. Lunden then assumed leadership of the Seed Testing Services and continued with the related activities of college teaching, coaching the Intercollegiate Crops Judging Team, and the holding of short courses for seedsmen.

KINCH HONORED A. O. Lunden

In June 1976, shortly before retirement, Professor R. C. Kinch was presented the Award of Merit, the highest honor bestowed by the Association of Seed Analysts of North America. It was presented as a tribute to his "scientific and educational contributions" and as "an inspiration to many, both on the state and national level." It is a vivid testimonial to the prominence of the SDSU laboratory and the state of South Dakota in seed testing, seed technology and seed law enforcement.

R. C. Kinch was also recognized for his work with seeds by being included in "Who's Who".

SAMPLES TESTED

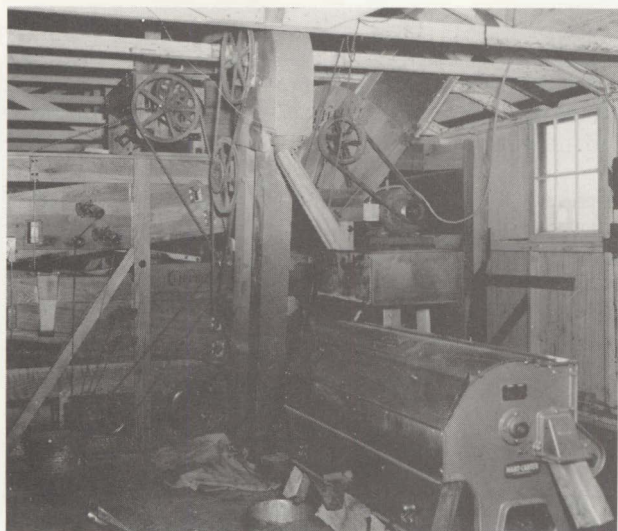
Number of Seed Samples Tested by the Seed Testing Laboratory

Fiscal year received	Origin of Samples			Total
	Service	Certifi- cation	Official	
1946	2243	560		2803
1947	2697	417		3114
1948	2326	849		3175
1949	2630	555		3185
1950	4463	950		5413

1951	4843	963	5806
1952	4798	1031	5829
1953	10202	891	11093
1954	9162	607	9769
1955	7442	916	8358
1956	8044	795	8839
1957	6909	788	7697
1958	7797	668	8465
1959	6196	933	7129
1960	5716	554	6270
1961	6184	631	6815
1962	5199	669	5868
1963	5067	505	5572
1964	6410	674	7084
1965	5091	723	5993

179

1966	4579	996	187	5762
1967	4210	1396	260	5866
1968	4807	1356	350	6513
1969	4080	1142	350	5572
1970	3635	1251	361	5274
1971	4586	1146	384	6116
1972	3923	1149	463	5535
1973	3474	1533	463	5470
1974	4287	1482	362	6131
1975	5097	1497	384	6978
1976	3484	1885	351	5720
1977	3647	1445	457	5549
1978	3628	1476	415	5519
1979	4070	1517	566	6153



First scalper and Carter disk in barracks, the first Foundation seed processing plant used during late 1940s and early 1950s.



Stan Peterson sacking processed Foundation seed in barracks.



A. Schooler, H.Lund, G.W.Erion, E. Wittrock processing corn inbreds raised by FSSD-1948.



Blanket cleaner used to remove wild oats from Foundation seed in mid-1950s.

CHAPTER XXXII SEED CERTIFICATION

Seed certification work in South Dakota is a service maintained by seed producers of the state. Its purpose is to produce and distribute, under the guidance and supervision of the State Seed Certification Board, SDCIA and South Dakota State University, pure seed of the improved varieties of crops so that the income from farming in the state may be more satisfactory.

Plant breeders are continually producing new superior varieties. Certification provides the means by which such Foundation seed may be increased, kept pure, and released as promptly as possible to the farmers of the state.

The grower of Certified seed must grow and market his crop according to definite rules and regulations so that the buyer will be protected against varietal mixtures, noxious weeds, diseases and other factors that affect purity and quality.

Certified seed must stand the test of being field inspected, and a representative sample of the cleaned seed must be analyzed in the State Seed Laboratory for purity, germination, noxious weeds and seed-borne diseases.

Under the Seed Certification Law enacted by the 1947 session of the State Legislature, the State Seed Certification Board has, for the purpose of promoting and protecting the interests and welfare of the South Dakota seed growers and crop producers, endorsed the standards of seed certification adopted by the SDCIA, a non-profit, educational and public service organization.

Upon evidence that the standards and regulations have been fully complied with by the applicant for seed certification, the State Seed Certification Board, or appointed agent, places the official South Dakota tag on all seed which has passed all the requirements for Certified seed.

The Certified seed tag when attached to the bag serves for identification as to genetic identity, purity, and freedom from disease. The certification number and producer number is also shown.

SEED CERTIFICATION PERSONNEL

Manley Champlin	? -1920	Supervisor
Ralph E. Johnston	1920-1935	Supervisor
R. W. Vance	1935-1941	Seed Commissioner
U. J. Norgaard	1941-1946?	Supervisor
Adolph O. Syverud	1947?-1953	Manager
G. Dwight Johnson	1942-1952	Assistant

J. Duane Colburn	1957-1978	Manager
Robert J. Pollmann	1978-	Manager

Records were not located to show when seed certification work began. It was, however, initiated by the South Dakota Experimental Association (JW-20). Manley Champlin, Supervisor of Experiment Stations in the Agronomy Department was its secretary, probably from 1912 until 1920. He was succeeded by R. E. Johnston, Extension Agronomist (JW-22). It is speculated that the secretary, a state employee, supervised the program from its starting date until 1925, when the Extension Agronomist was assigned the responsibility of directing the seed certification program (JW-29). Johnston and his successor, U. J. Norgaard, had that responsibility until the mid-1940s, except for a 6-year period when the State Seed Commissioner was in charge of it. In the mid-1940s, perhaps 1947, A. O. Syverud, who was Manager of Foundation Seedstocks Division, also took charge of the Seed Certification Service. In 1953 G. Dwight Johnson, who had been Assistant Manager, took charge. When Johnson retired in June 1960, J. D. Colburn, who had been Assistant Manager of FSSD for 3 years, assumed the added responsibilities as Manager of the Seed Certification Service. He had been a vocational agricultural instructor at Willow Lake and Clear Lake and had served as field inspector for several years. He had charge of certification for 18 years. When he resigned, he was succeeded by R. J. Pollmann, who had taught vocational agriculture at Brandon for 17 years and had been a field inspector for 15 years.

Prior to 1900, the general concept of Crop Improvement varietal purity and the importance of it was hazy. Varieties, selections or introductions were being released with relatively little information about their adaptation, performance, or productive capacity. In the early 1900s, after the release of a new variety, the agronomy research worker found the variety so completely contaminated in the 3 to 4 years that its identity and value were essentially lost to the seed buying public.

It was sometimes the tendency of unthinking individuals to rename varieties after release: Fultz wheat, for example, was reported to have been sold under 24 different names. Silvermine oats had 18 names, and Midwest Soybeans, 24 names (Weber).

SEED QUALITY

Seed improvement work began during the early 1900s. Crops of the time were very

heterozgous. Plant breeders made hundreds of head selections from various crops, planted the seed from each head in individual head rows and selected for uniformity of various characteristics.

Eventually, they discarded seed from head rows that did not outyield the parent population by at least 10% (Bul 183).

By 1909 Agronomists urged corn growers to be more careful when selecting seed. The best place to select seed was in the field before a killing frost. It was suggested that farmers select mature ears with medium sized kernels from strong healthy stalks (Bul 118).

In 1922 it was suggested that a few rows of forage sorghum be allowed to mature and that large, compact, heavy heads be selected from sturdy leafy plants (Bul 135).

In 1916 A. J. Wimple requested that the South Dakota Corn and Grain Growers Association issue certificates of registration for outstanding selections of South Dakota corn in an attempt to keep such varieties pure (JW-11).

Six years later the organization passed a resolution stating, "The growing and marketing of seed is a commercial proposition. We recommend and encourage the formation of an independent organization of growers of specific crop seeds for the purpose of certifying the product grown and marketed by its members" (JW-17).

FIRST SEED CERTIFICATION PROGRAM

The South Dakota Experimental Association apparently started a certification program. Membership in the organization, formed in 1912, was limited to graduates of SDSC and the School of Agriculture. Its function was to assist the college in the testing of new crops and varieties and to disseminate seed of proven crops and varieties (JW-21).

Each year members of the organization received a price list of seed available from the Experiment Station and substations (Bul 183).

Ralph E. Johnston, secretary to the organization, stated in his 1924 Extension Agronomy annual report that 20 fields totaling 190 acres of potatoes were inspected for certification in cooperation with the South Dakota Potato Growers Association. He reported that 128 acres passed all three inspections.

In 1924 the president of the South Dakota Corn and Grain Growers Association was directed to appoint a committee on seed certifica-

tion which would take over the function of seed certification previously handled by the South Dakota Experimental Association (JW-20).

During the next year the SDC&GGA and SDEA merged to form the South Dakota Crop Improvement Association (JW-23).

At a conference of A. N. Hume, Head of Agronomy; R. E. Johnston, Extension Agronomist; and W. F. Kumlien, Director of Extension, on January 2, 1925, the following general points were agreed to as a basis for doing seed certification work in 1925:

1. It is assumed and favored that the South Dakota Crop Improvement Association will continue the certification project formerly sponsored by the Experiment Association.

2. The college is willing to continue to assist in this program providing its help is needed and until such time as the Crop Improvement Association can take it over: provided further that the work expected of the college is educational in character.

3. A system of certification rules and rates of fees should be adopted by the Crop Improvement Association whereby certification work will be as nearly self-supporting as practicable.

4. The Extension Agronomist will adopt seed certification as one of his sub-projects for the year and a definite time will be set aside in his schedule for this work.

5. The Crop Improvement Association will pay 75% of all certification fees collected to the Extension Service toward the expenses of the Extension Agronomist for assistance rendered (JW-29).

The plans were approved at a special meeting of the executive board on March 4 and 5, 1925. Also present were Extension Agronomist R. E. Johnson, Director of Extension W. F. Kumlien, and Dean of Agriculture C. Larsen (JW-29).

Direction was given that the secretary shall act as treasurer of the Association pursuant of a motion made and carried by the board at the Pierre meeting to the effect that the secretary shall be empowered to arrange for the disbursement of funds appropriated by the legislature under the approval of the Board of Regents of Education and of such other funds as may be collected by the Association for membership fees, certification dues, etc. (JW-29).

R. E. Johnston was to direct seed certification and registration as assistant-secretary of the Association (JW-29).

Johnston developed a program for the production of certified seed of small grains and flax and SDCIA members began producing the seed. During the next few years a program to produce Registered seed of sweetclover and alfalfa was developed by Johnston and growers began producing seed in 1929.

In 1928 it was decided that a South Dakota Seed Council be formed consisting of representatives of the following:

South Dakota Crop Improvement Association--1 delegate.
South Dakota Farm Bureau--1 delegate.
South Dakota Farmers' Union--1 delegate.
South Dakota State Grange--1 delegate.
South Dakota Farmers' Elevator Association--1 delegate.
South Dakota State Department of Agriculture--1 delegate.
South Dakota Extension Service--1 delegate.
South Dakota Agronomy Department--1 delegate.
South Dakota Seed Dealers--2 delegates (JW-34).

Meetings were held in Huron in September and in Brookings in December to outline definite work for the Council. The three following projects were selected:

1. The formulation of a state seed law based upon the uniform seed law.
2. Seed Certification of potatoes, small grain, and flax.
3. Formulation of a seed alfalfa law providing for the inspection of fields, certification of seed, and sealing of sacks (JW-34).

A class "Certified Seed" was added to the 1930 State Crop Show to stimulate interest in improved varieties and better seed (JW-35).

STATE SEED COMMISSIONER

A proposed seed law was explained at the 1935 SDCIA annual meeting by K.H.W. Klages and others. The law was passed in 1935 which provided for a State Seed Commissioner appointed by the Governor to be located at SDSC and administer seed analysis, seed certification and registration (JW-39).

By 1938 there was considerable dissatisfaction with the Seed Commissioner and his handling of seed certification, increase of new varieties and the distribution of seed of new varieties to farmers. The SDCIA felt that seed certification should be in the hands of the SDCIA in cooperation with SDSC. E.G. Sanderson said there was a need for county associations to assist in certification and

distribution of new varieties (W-42).

SEED CERTIFICATION SERVICE ESTABLISHED

The 1939 legislature abolished the office of State Seed Commissioner and transferred its powers to the South Dakota Secretary of Agriculture. The secretary in turn, transferred the seed certification work to the SDCIA, and the seed testing work to SDSC. The regulatory responsibility was retained by the Secretary of Agriculture (JW-43).

A special meeting was held in Huron on March 22, 1939, to organize the Seed Certification Service. The organizations represented were: South Dakota Crop Improvement Association, South Dakota Potato Growers Association, Extension Service, Agronomy Department and State Department of Agriculture (JW-43).

U. J. Norgaard, Extension Agronomist, was elected secretary to fill the vacancy caused by the resignation of Rex Bankert (JW-43).

At the Huron meeting the following arrangements pertaining to certification were adopted:

1. Under the section of the law defining cooperative functions, the Secretary of Agriculture agreed to endorse standards of seed certification adopted by the SDCIA.

2. Since the 1939 Seed Certification Law designated the Department of Agriculture as the official agency to certify seed, the Secretary of Agriculture or his agent will, upon evidence that the standards and regulations have been fully complied with by the applicant for seed certification, place the official South Dakota tag and seal upon the seed.

3. Any seed grower whose crop originated from certified seed of the adapted varieties accepted for certification in South Dakota is eligible to have his field inspected.

4. Field inspection will be made by trained inspectors employed by the SDCIA after being endorsed by the Department of Agronomy and approved by the Secretary of Agriculture.

5. All applications for tests of seed certification must be sent to the SDCIA, Brookings, S.D., not later than June 20.

6. The field inspection fees are \$3.00 for 30 acres or less and 10¢ for each additional acre. The fee must be paid before field is inspected. The field inspection fee must be sent to the SDCIA, Brookings, S.D., at the time application is sent. All money is returned if field is not inspected.

If seed grower is not a member of the SDCIA, \$1.00 in addition to the regular inspection fees will be collected to help pay for cost of handling his office records. (\$1.00 is the annual dues of the members of the SDCIA). A fee of 5¢ per bag will be charged on all certified seed when it is sealed and tagged. Note: The above schedule is subject to change in accordance with the volume of certification performed. The principle which will be followed is that the producer of certified seed will be charged only the actual costs of making the necessary field and laboratory inspections.

7. A threshed quart size sample of the seed from the inspected field, accompanied by a guarantee of the grower that it is a representative sample of the seed held for sale, must be submitted to the SDCIA, Brookings, S.D., for testing.

8. Every grower of certified seed must make a signed statement to the SDCIA, Brookings, S.D., as to the amount of such seed for sale, as per sample submitted for final test upon which certification is made. A copy of this statement will be sent to the Department of Agriculture, Pierre, S.D.

Sales must be reported to the SDCIA. All sales are made directly between grower and buyer of seed. A copy of the sales reports will be sent to the Department of Agriculture, Pierre, South Dakota (JW-44).

Other resolutions:

1. The SDCIA shall submit to the Secretary of Agriculture their standards on certification of all crops, grains, and seeds.

2. The SDPGA shall submit their rules, regulations, and standards on certification of seed potatoes to the Secretary of Agriculture.

3. The Secretary of Agriculture will, under this agreement and in accordance with the section of the law under cooperative functions, enter into a cooperative agreement with the SDCIA in regard to inspection and certification of seed.

4. It was to be understood that any other seed organization may, at the discretion of the Secretary of Agriculture, have the same privilege, however, no seed organization would be eligible for such privilege unless the certification standards were equal to those set by the SDCIA or the SDPGA.

5. The president of the SDCIA or his duly authorized representative and the president of the SDPGA or representative shall be authorized to enter into cooperative agreement with

the Secretary of Agriculture in regard to this matter at such time and place as they may mutually agree upon (JW-44).

At the annual SDCIA meeting in November, 1939, a certification committee was selected, consisting of: Frank Swope, Frank McHugh, U.J. Norgaard, Dr. Stanley Swenson, Gale Peppers, J.J. Martin, and Otto Sundstrom. This committee met in December to work out many details. One interesting detail was the removal of sweetclover from the list of noxious weeds as they pertained to alfalfa. Seed sealing was to be handled by county agents under the justification that this was part of the education program of the production of certified seeds (JW-45).

Certification Regulations

In January, 1940, the certification committee met at SDSC to discuss certification of hybrid corn. The certification of hybrid corn had been somewhat complicated and difficult to control. The regulations were as follows: The performance of a certified commercial hybrid (1) must equal the average of the better open-pollinated varieties in lodging resistance, (2) must produce at least 10% more grain of the same quality and (3) must have the combined advantage in lodging resistance and yield of not less than 25%. These records must have been made in each of 2 years, both within the 5-year period immediately preceding such certification. The record of performance of such hybrids, obtained for the individual controlling the inbred lines may be used by any person or concern asking for certification providing the hybrid is identified with the one on which the record is based (JW-45).

Certification would be made with blue, red and yellow tags for hybrid seed corn which is (1) true to name, (2) has passed field inspection for off-type plants, (3) the tolerance standard for detasseling, (4) isolation requirements, (5) seed house inspection for off-type and doubtful ears and (6) laboratory germination and purity tests (JW-46).

In addition to the requirements for blue, red, and yellow tag certification, the SDCIA would also certify to the quality and genuineness of hybrid strains which had not yet been performance tested in South Dakota but which, on the basis of performance tests in other states under conditions which might be similar to South Dakota conditions, possess factors which made them adapted to South Dakota. A white tag would be used (JW-46).

These rules involved a number of problems such as (1) the tests were not conducted over a long enough period to be satisfactory, and (2) out-of-state companies were selling seed

in South Dakota with blue and other colored tags from other states (JW-46).

In July further work by the certification committee eliminated the use of various colored tags for certified seeds, adapting the blue tag only in all certification except for alfalfa where the red tag was also to be used. Also at this meeting, the primary and secondary noxious weeds were designated and certification standards for small grain and alfalfa were adopted (JW-47).

The standards for certification regulations were taken from the regulations of the International Crop Improvement Association (JW-45).

At an SDCIA board meeting at SDSC on July 1, 1941, the growing of certified alfalfa seed on the same farm with other alfalfa was discussed. In order to be consistent with other states, the regulation that prohibited such a practice was changed to read: "No other alfalfa can be produced for seed on the same farm that is producing certified alfalfa seed." It could therefore be grown for hay (JW-47).

Another problem dealt with the selling of hybrid seed corn in South Dakota. Some states were prohibiting the sale of hybrid seed corn unless it was certified by an official agency. The board recommended to the Secretary of Agriculture that "his department shall permit no person, firm, or corporation to sell hybrid seed corn in South Dakota until said person, firm or corporation shall have satisfied the Secretary of Agriculture as to the quality and worth of said hybrid seed corn" (JW-47).

It was decided that membership on the seed certification committee be increased from seven to eleven members so that all interests in seed improvement would be represented--corn, small grain, sorghum, alfalfa, grasses, potatoes, State Department of Agriculture, Head of Agronomy, Seedsmen's Association and Secretary of SDCIA, S.D. Horticultural Society. Chairman E. G. Sanderson, was an ex-officio member (JW-50).

Seed Certification Policies

The committee adopted policies in 1944 that put certification on a sound basis. They are as follows:

1. The committee approved the policy of certification services for both the genetic purity and geographic origin of hardy crops which stood the climatic rigors over a period of years.

2. South Dakota standards could profitably be higher than the international standards in certain instances where South Dakota producers had a natural advantage over other states.

3. South Dakota would accept certification for crops, seed of which is produced for out of state demand. It shall be the duty of the executive committee to designate varieties which may be certified. Varieties known to be unadapted to South Dakota conditions will be certified only upon the approval of the executive committee.

4. Old fields of alfalfa, if approved as worthy, will be certified as South Dakota hardy alfalfa.

5. Open-pollinated corn of old standard varieties shall be eligible for certification.

6. Grades of certified seed would be designated as A, B, and C instead of 1, 2 and 3, in order to prevent confusion with market grades.

Seed Certification Service Legalized

In 1947 the legislature passed a bill that legalized the certification work carried on by the SDCIA.

No particular change was made in the certification procedure or organization except the method of selecting the Certification Board. It had previously been selected by the Association. The new law specified that the Secretary of Agriculture appoint a five-man board from nine men recommended by the following organizations: SDCIA, two men; South Dakota Horticulture Society, two men; Dean of Agriculture, four men; and State Division of Plant Industry, one man (JW-53).

At this time the certification was being handled by A. O. Syverud and G. D. Johnson in the certification office. Most of the field inspection work was being done by the Smith-Hughes vocational agriculture instructors who were given special training in this work each year. This experience proved to be mutually beneficial to the certification work and as training for teaching agriculture (JW-53).

The SDCIA continued to appoint a seed certification Committee. Each of the members was appointed to a 5-year term and represented growers of specific crops (corn, sorghum, small grains and flax, alfalfa, grass seed and soybeans) and several organizations (S.D. Department of Agriculture, Agronomy Department, S.D. Seed Trade Association, SDCIA and South Dakota Horticulture Association). U. J. Norgaard was secretary until he retired, then the position was filled by the manager of Seed Certification Service.

General Standards

1. Certifying Organization

Under the authority of the State Seed Certification Board, certification will be

conducted by the South Dakota Crop Improvement Association, a non-profit, educational and public service organization with a close working relation among seed growers and agricultural research, extension and regulatory agencies.

2. Purpose of Certification

The purpose shall be to maintain and make available to the public through seed certification, high quality seeds and propagating materials of superior crop plant varieties so grown and distributed as to insure genetic identity, genetic purity and freedom from noxious weed seeds.

3. Eligibility Requirements For Certified Crop Varieties

Only those varieties that are approved by the certifying agency shall be eligible for certification. For those crops where national certified Variety Review boards exist, it is recommended that varieties be submitted for review to determine their merit for certification. Any crop variety for which a Plant Variety Protection Certificate has been issued shall be eligible for certification.

4. Classes and Sources of Certified Seed

Four classes of seed shall be recognized in seed certification namely: Breeder, Foundation, Registered and Certified. These classes of seed shall meet the requirements included in the Association of Official Seed Certifying Agencies standards for the respective crops. These classes are defined as follows:

Breeder seed is seed or vegetative propagating material directly controlled by the originating, or in certain cases the sponsoring plant breeder, institution, or firm, and which supplies the source for the initial and recurring increase of Foundation seed.

Foundation seed shall be seed stocks that are so handled as to most nearly maintain specific genetic identity and purity. Production must be carefully supervised and approved by the certifying agency and/or the Agricultural Experiment Station.

Registered seed shall be the progeny of Foundation seed that is so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency. This class of seed should be of a quality suitable for production of Certified seed.

Certified seed shall be the progeny of Foundation seed or Registered seed that is so handled as to maintain satisfactory genetic

identity and that has been approved and certified by the certifying agency.

5. Limited Generations

The number of generations eligible for certification varied from crop to crop, but was unlimited for some crops until the mid-1960s. For most crops, Breeder seed was planted to produce Foundation seed which was planted to produce Registered seed which could be used to produce Certified seed. Certification standards were lower for each succeeding generation or seed class, so it was possible to produce Certified seed from Foundation seed, for example, if the seed did not meet the standards for Registered seed.

Certified seed of self-pollinated crops (small grains, flax, soybeans and millets) could be planted to produce Certified seed for an unlimited number of generations. In 1968 plant breeders began to "protect" the varieties they produced with a Plant Variety Protection Certificate. The developing breeder or organization had the privilege of specifying the number of generations that were eligible for certification. Most of them "limited the generations" from which Certified seed could be produced. The Registered seed class was usually dropped. Foundation seed had to be planted in order to produce Certified seed and Certified seed was not eligible for recertification.

The State Seed Certification Board was obliged to follow the specifications pertaining to "limited generations". The modified standards specified that the number of generations through which a variety may be multiplied shall be limited to that specified by the originating breeder or owner of the variety and shall not exceed two generations beyond the Foundation seed class with the following exceptions:

- a. Recertification of the Certified class may be permitted for older varieties where Foundation seed is not being maintained.
- b. The production of an additional generation of the Certified class only may be permitted on a one-year basis, when an emergency is declared prior to the planting season by the certifying agency stating that the Foundation and Registered seed supplies are not adequate to plant the needed Certified acreage of the variety. The permission of the originating or sponsoring plant breeder, institution, firm or owner of the variety, if existent, must be obtained. The additional generation of Certified seed to meet the emergency need is ineligible for recertification.

Standards for open-pollinated crops and hybrids included limited generation restrictions for many years. For alfalfa clovers and trefoil, it was essential to plant either Foundation or Registered seed in order to raise Certified seed. Seed for commercial corn or sorghum hybrids could not be certified unless it was produced from Certified Foundation seed approved by the Agricultural Experiment Station and/or a certifying agency.

6. Production Inspected

Because commercial producers of hybrid corn and/or sorghum seed would not reveal the identity of the parents, their hybrids were not eligible for certification. A "Production Inspected" classification was initiated during the mid-1960s. A white tag was used to indicate that the seed met the same standards of field inspection and seed laboratory analysis as Certified seed, but did not certify as to the genetic identity of the seed.

TWENTY ESSENTIAL STEPS IN THE PRODUCTION OF CERTIFIED SEED U. J. Norgaard

Seed certification in South Dakota is a service maintained by seed producers of the state. The objective is to produce and distribute, under the guidance and supervision of the South Dakota Crop Improvement Association, Agronomy Department; South Dakota State College and the Department of Agriculture at Pierre, pure seed of the improved varieties of crops so that the income from farming in the state may be more satisfactory.

The outline below is presented to assist the grower in the important work of producing seed which will qualify for certification. Unless these essential precautions are taken the grower should not attempt to grow certified seed.

1. If interested, send for "Seed Certification Standards for South Dakota". Address: Seed Certification Service, College Station, Brookings, South Dakota. Study program thoroughly.

2. Use Foundation or Certified seed eligible for certification in South Dakota.

3. Land treatment previous year: Refer to standards for specific crops.

4. Seed treatment important: Refer to Standards.

5. Noxious weeds: No tolerance. Refer to Standards.

6. Take care of isolation requirements. Refer to Standards for specific crops.

7. Clean planting equipment of all seed before planting certified seed.

8. Make application for field inspection. Read and study application blank before signing. Send application to: SEED CERTIFICATION SERVICE, COLLEGE STATION, BROOKINGS.

9. Rogue all fields of weeds or mixtures before field inspection.

10. Applicant will accompany field inspector when field is examined. Sign field inspection report together with field inspector.

11. Do not harvest seed before it is fully matured.

12. Clean harvesting machinery (including corn pickers) thoroughly before starting harvesting.

13. Clean bundle racks before hauling.

14. Clean all parts of threshing machine (or combine) thoroughly before combining. Run gunny sacks through all auger conveyers by hand several times before threshing in order to remove grain lodged in bottom of conveyers.

BLENDING AND PROCESSING

During the 1950s the volume of Certified seed moving through regular seed trade channels was increasing every year. The dealers had facilities to handle more Certified seed than in the past, and claimed they could do so, if they could blend and upgrade small lots of seed eligible for certification and complete the certification procedure themselves.

This had not been possible, but a change in the seed law permitted seed processors to blend, clean and complete the certification on producer lots of seed eligible for certification.

On November 13, 1957 representatives from the SDCIA, South Dakota Seed Trade Association, the Agronomy Department and the South Dakota Seed Certification Board met to devise a system whereby seed dealers could buy, blend, process, complete the certification and sell the Certified seed in order to facilitate and further increase the volume of Certified seed moving into and being handled in regular seed channels. They developed the following arguments:

Approved Certified Seed Processing Plants

An approved seed processor is an individual, partnership, or corporation that buys, cleans, blends and completes the certification

on lots of seed from fields that have passed field inspection and is approved and recommended for cleaning of seed from inspected fields.

In order to become an approved processor, an application shall be made in writing to the SDCIA, Brookings, S.D. Application forms are available upon request. This blank shall be filled out and returned together with a remittance of \$25.00 to the SDCIA to cover the initial inspection of the seed house and its equipment and other related costs.

All accepted processors of Certified seed must have been approved by the Committee on Processing Plants, the SDCIA, the Seed Certification Board. The committee on seed processing consists of one person appointed by the SDCIA, one appointed by the Agronomy Department and one person appointed by the South Dakota Seed Trade Association.

Subsequent annual fees of \$10.00 are charged for each processing plant in good standing. This fee provides for periodic inspection and for membership in the South Dakota Crop Improvement Association.

Transfer of Seed

In order for a grower to transfer field inspected seed to an approved processor who completes the certification procedure several steps must be taken:

1. The grower must fill out and mail to the Certification Service, Brookings, South Dakota the "Record of Transfer" form (furnished upon request) when field inspected seed is sold to an approved processor.

2. The approved processor must take a representative sample of the seed (two quart of small grain, and one quart of grasses and one pint of small seeded legumes) before the lot of seed is cleaned or processed.

3. The processor must send the representative sample of the cleaned seed to the Seed Certification Service for the seed laboratory inspection. The required number of tags and seals are to be ordered after the seed has passed this inspection.

4. The Seed Certification Service reserves the privilege of making inspections and taking samples during or after processing and sealing.

5. The grower of the seed is indebted to the SDCIA for the 2% sales fee.

6. New bags must be used when sacking Certified seed.

7. The SDCIA and Seed Certification Service are non-profit public service agencies and assume no responsibility regarding the seed, although every attempt is made to insure high quality and conformity to the Certification Standards. The owner of the seed is required to take the representative samples and is responsible for the seed label information.

Seed Blending

Different lots of field inspected seed of the same crop variety produced by one or more growers may be blended by approved processors provided:

1. There is adequate equipment to blend the seed uniformly.

2. Accurate records, weights and samples are kept of the individual lots making up the blend. This record must be furnished to the Seed Certification Service. Samples are to be retained for at least one year and be available upon request to the Seed Certification Service.

3. A lot number shall be assigned to each blend at the time the blend is made.

4. A sample of the blended seed shall be sent to the Certification Service for laboratory inspection as soon as the blend is completed.

5. The party or parties making the blend shall assume all responsibility in case the seed fails to qualify for certification for any reason.

Custom Seed Cleaning by Approved Processors

Growers with seed from inspected fields may take their seed to an approved processor where seed cleaning will be done in a seed plant that has good equipment, a skilled operator and is operated by a person who is interested in turning out a superior product. Certified seed growers are recommended but not required to take their seed to such plants.

1. A representative sample of the seed must be taken by the processor before it is cleaned. This sample is to be retained at least one year.

2. A "record of processing" form must be filled out and sent to the Seed Certification Service as soon as a lot of field inspected seed has been cleaned.

3. The grower retains ownership of the seed and is responsible for taking the representative sample to be sent to the Seed

Certification Service for the laboratory inspection.

4. The grower of the seed assumes all responsibility in case the seed fails to qualify for certification.

ACREAGE OF CERTIFIED SEED

Acres of crops that were entered for seed certification and the number of acres rejected by inspection.

Year	Applied for Certification Acres	Rejected Acres
1924	190	32
1945	9,111	-
1950	34,384	8,300
1951	23,882	-
1952	29,908	805
1953	29,381	509
1954	23,219	598
1955	31,115	482
1956	24,077	400
1957	23,618	164

1958	24,125	322
1959	17,581	118
1960	15,281	30
1961	15,928	299
1962	14,247	134
1963	14,671	106
1964	14,685	158
1965	20,228	866
1966	32,650	916
1967	35,436	342
1968	34,312	712
1969	30,502	1,066
1970	30,880	813
1971	30,001	572
1972	33,932	1,047
1973	42,143	1,098
1974	40,013	663
1975	48,006	1,708
1976	49,898	1,284
1977	40,334	1,608
1978	45,942	1,004
1979	49,046	645
1980	61,090	3,413
1981	60,925	1,533

TOTAL 658,199



Roguing off-type plants from Foundation seed field.



J.D.Colburn, Seed Certification, P.B.Price, USDA barley breeder and G.W.Erion, FSSD examining Primus barley for off-types.



J.D.Colburn making field inspection of Certified or Foundation seed field.

CHAPTER XXXIII FOUNDATION SEED STOCKS DIVISION

The Foundation Seed Stock Division increases plant varieties developed by Agriculture Experiment Stations and releases them to growers. These farmer-growers sell the seed they produce to other farmers that have been growing a less desirable variety. Thus, the Foundation is responsible for making Experiment Station-released varieties available to the commercial grain farmers as rapidly as possible. Starting in 1973 varieties developed by some commercial plant breeders were made available to South Dakota farmers through the FSSD.

The FSSD receives no tax money to pay salaries, erect buildings or for operation and maintenance. All money comes from the sale of its seed.

FSSD PERSONNEL

Adolph O. Syverud	1943-1956	Manager
Gerhardt W. Erion	1948-1956	Assistant Manager
	1957-1967	Manager
J. Duane Colburn	1957-1967	Assistant Manager
	1968-1968	Acting Manager
	1969-1972	Manager
Wayne G. Wright	1963-1964	Assistant Manager
James B. Weber	1968-1972	Assistant Manager
	1973-	Manager

Manley Champlin, Supervisor of Experiment Stations in the Agronomy Department, probably had charge of seed distribution from research plots at the Experiment Station and substations prior to 1920 and E. W. Hardies for several years during the 1920s. They also may have increased and distributed seed of new varieties. They may have been succeeded in this effort by K. H. W. Klages and S. P. Swenson. It was Swenson who announced to the SDCIA in 1940 that 900 bushels of Miomark oats were available for distribution (JW-47).

A. O. Syverud was Manager of the FSSD from its beginning in 1944 until his death in 1956. G. W. Erion, who had been Assistant Manager for 8 years then served as Manager until 1968. While he was in India during 1963-1964 to assist with the establishment of a Foundation seed program, W. G. Wright served as Acting Manager. J. D. Colburn was employed in 1957 as a part-time Assistant Manager. Since Teton alfalfa was being increased at that time, he became production manager for forage crops--a responsibility he retained for about a decade.

After Erion was overcome by carbon monoxide gas in January 1968, Colburn assumed the role of part-time Acting Manager while Erion was recuperating. When it became apparent that

Erion would not fully recover, Colburn left the FSSD to return full-time to the Certified Seed Service. J. B. Weber, who had been Assistant Manager for about 5 years became the Manager.

EARLY SEED DISTRIBUTION

The problem of distributing seed of new crops and new varieties was encountered before the turn of the century. The problem of developing and maintaining seed uniformity and quality and crop uniformity developed shortly afterwards. When the USDA started to secure seed from foreign countries, small quantities of seed were distributed by Congressmen to farmers back home free of charge. Occasionally, a careful farmer succeeded in supplying his neighbor with seed, but most of the seed lots were soon lost. From Agricultural Experiment Stations, chemists, botanists and agriculturists distributed handfuls of new seed to acquaintances for their use and for further distribution.

Later, Agricultural Experiment Stations released new varieties to graduates or former students of their College of Agriculture. This was an improvement because the individuals receiving the seed had a certain amount of training. The quantity of seed was larger, and there was usually some type of follow-up.

In 1891 J. H. Shepard distributed over 500 packets of sugar beet seed in 42 counties. His objective was to determine if and where the crop was adapted to South Dakota conditions. That fall he received reports from 125 growers and concluded that sugar beets could be grown in most any part of the state (Bul 27).

N. E. Hansen in 1911 obtained an appropriation of \$2,000 from the state legislature for use in distributing and testing the alfalfas he obtained in Russian and Siberia. In a news story he offered to give ten alfalfa plants to each of the first ten applicants in each county. During a 2-year period he sent transplants to upwards of 1,500 farmers to space plant in their gardens to get maximum plant growth and seed production. He received evaluation reports from 115 farmers (Bul 141).

Starting in 1912, the Agronomy Department planted seed of the best known varieties on research plots at Brookings and the four substations (Ful 183). Since plot size ranged from 1/10 to 1 acre, a relatively large amount of seed was harvested and threshed. A policy was adapted which included some of the facets of the modern day seed distribution and certification programs.

The seed was thoroughly cleaned and graded and sold to farmers for seed. On December 1 each year, a price list was circulated to members of the South Dakota Experimental Association and others who requested it. The price charged was the approximate market value plus the costs of sacks, cleaning, grading and shipping (Bul 183).

Complete records were kept for each farmer showing the variety name, registry number, amount of seed and date of purchase. A tag on the shipment gave the germination and purity. Each farmer was asked to report on its behavior, compare it to another variety if possible and, if it gave good results, to increase it and sell it to other farmers (Bul 183).

Crops grown on the research plots and were probably released in this manner include the following: Swedish Select, Cole, Sixty Day, Richland and Gopher oats; White Smyrna, Odessa, Manchuria, Hannchen, Ace, Coast, Lyon, Oderbrucker and Primus barley; Red Fife, Bluestem, Marquis, Kota, Reward, Hope and Ceres hard red spring wheat; Kubanka (Wild Goose) and Velvet Chaff durum wheat. (There was a barley variety named Primus that was grown in the early 1900s.) Other varieties raised on the research plots included Minn-13 (Highmore 13, Eureka 13, Vivian 13, SD 86 later named Alta), all Dakota and Rainbow Flint corn, Advance winter rye, Primost flax, Minnesota Amber and Dakota Amber forage sorghum, Altamont grain sorghum; Cossack, Ladak, Grimm and Baltic alfalfa; yellow-flowered and white-flowered sweetclover; and smooth brome-grass.

A somewhat different system was used to distribute Acme durum which was named in 1915. The next year E. S. McFadden sent one bushel each to his father at Webster and E. L. Bolland near Pierpont.

Seed was sold to farmers in six counties in 1917 and in 11 more counties in 1917. Yield comparisons were made with other varieties of grain under similar conditions. Most farmers did not make yield comparisons in 1919, but 47 farmers in Clark County each planted one bushel of Acme beside another variety for comparison (Bul 194).

Seed was distributed and evaluated for yield at the same time. It was recommended for production in 1921 (Bul 194).

FORMATION OF FSSD

The SDCIA program committee report in 1936 stated in part that variety standardization and seed certification must be encouraged and the volume increased. There should be started a system, like in Minnesota, where increase

fields of the adapted varieties of crops are produced by the Agronomy Department, which seed is then put into the hands of approved seed growers, under agreement, to increase for more general distribution (JW-41).

The Certification Committee met in Brookings, January 3, 1940, to formulate certification policies. Others who met with the committee were E. L. Erickson, seed analyst at the college, Dr. A. N. Hume, and Hugh Frandsen, County Extension Agent at Brookings (JW-45).

One of the two principal problems discussed dealt with the disposition and certification of Foundation seed released from the college (JW-45).

It was decided that Foundation seed be released to the County Crop Improvement Associations (JW-45).

The problem of increasing Foundation seeds was often discussed by members of the SDCIA. On July 1, 1943 A. O. Syverud, a native of Canton and County Agent at Clear Lake, was employed to plant small amounts of Breeders seed to produce larger amounts of Foundation seed.

Plans for the establishment of a Foundation Seed Stock Corporation were becoming a reality at the close of 1943. The effect of new assistance in certification and Foundation seed production was being felt by the addition to the Agronomy staff of W. W. Worzella, A. O. Syverud and G. D. Johnson (JW-48).

The Foundation Seed Stocks Division of the South Dakota State College Foundation was activated at the board of directors meeting of the State Crop Improvement Association on February 2, 1944. Its function was to increase varieties developed by the South Dakota Experiment Station and to maintain pure seed reserves of standard varieties (JW-49).

The Foundation Seed Stock Division Board of Directors included six college administrators, by virtue of their offices: President of SDSC, Dean of Agriculture, Director of Experiment Station, Director of Extension Service, Head of Department of Agronomy and Extension Agronomist.

The first board included nine SDCIA members, but was later reduced to include farmers, nominated and approved by the SDCIA for staggered 3-year terms. They represented the major crops and production areas of the state.

The first board of directors of the FSSD included the following men: Lyman Jackson,

President of SDSC; A. M. Eberle, Dean of Agriculture; I. B. Johnson, Director of Experiment Station; John V. Hepler, Director of Extension; W. W. Worzella, Head of Agronomy Department; U. J. Norgaard, Extension Agronomist; E. G. Sanderson, representing corn; Frank Swope, representing small grain; Everett Fletcher, representing potatoes; Cole Burton, representing alfalfa; and Frank Cundill, representing other crops. Worzella was elected chairman. However, in 1945 the board included three SDSCIA members appointed for 3-year terms, three for 2-year terms and three for a 1-year term. They were: E. G. Sanderson, Aurora; Frank Swope, Orient; Henry Preheim, Marion (for 3 years); Frank Cundill, Isabel; Frank McHugh, Aberdeen; Gale Peppers, Huron; A. G. Vincent, Letcher (for 2 years); and Everett Fletcher, Garden City; Cole Burton, Piedmont; Ed Habeger, Ideal; Richard Burn, Mitchell (for 1 year).

The officers were E. G. Sanderson, president; Frank Swope, vice president; U. J. Norgaard, secretary; and A. O. Syverud, Manager (JW-49).

Articles of Incorporation of the FSSD were written and signed in Brookings and filed with the Department of State in March, 1945. The By-Laws were written and signed by the Board of Directors in April, 1945. The Memorandum of Understanding between SDSC and the FSSD was signed by officers of the FSSD and by officers of the Board of Regents of Education in May, 1946.

ARTICLES OF INCORPORATION

KNOW ALL MEN BY THESE PRESENTS:

That we, the undersigned, W. W. Worzella, A. M. Eberle, and U. J. Norgaard, for ourselves, our associates and successors, have associated ourselves together for the purpose of forming a corporation under and by virtue of the statutes of the State of South Dakota, and we do hereby certify and declare as follows, viz:

Article I Name

The name of this corporation shall be Foundation Seed Stock Division of the South Dakota State College Foundation (abbreviated to FSSD).

Article II Purpose

The FSSD shall be entirely non-profit and shall be organized and operated exclusively for scientific and educational purposes and for the promotion of the social and economic

welfare of the people, and no part of the net earnings of the corporation shall inure to the benefit of any member of the corporation, and the purpose for which the corporation is formed is to aid in the development, production, and the distribution of Foundation seed stock in the interest of the people of South Dakota, and this purpose shall be attained in any lawful manner and, without limitation, more particularly as follows:

(1) By accepting consignments of developed material from the Experiment Station of South Dakota State College of Agriculture and Mechanic Arts (hereinafter called SDSC) for purposes of their management in the interests of the people of South Dakota.

(2) By maintaining a supply and reserve of pure seed stocks as Foundation source material.

(3) By increasing the stocks of Foundation seeds and plant materials sufficiently to make possible their distribution through sales to crop improvement groups entitled to receive such stocks.

(4) By cooperating with all Experiment Stations and institutions in using and preserving supplies of superior plant germ plasm.

(5) By cooperating with all institutions, agencies, corporations and individuals interested in developing, preserving, protecting, disseminating and using Foundation materials.

(6) By the making of grants in aid of research in the development of Foundation seed stocks to the Agricultural Experiment Station.

(7) By the making of grants to SDSC for scholarships, fellowships and lectureships or other educational projects having a relationship to the objectives of the corporation.

(8) By investing and managing of funds and other property for the increasing of the corporation assets to be used in the furtherance of the purposes of this corporation.

(9) By exercising any and all lawful business and commercial practices such as receiving gifts, borrowing money and securing the same, the owning, leasing, holding, administration and disposition of real and personal property, money and securities and all other necessary or incidental practices as may be necessary, incidental or convenient to the purposes above mentioned.

(10) By quick liquidation in the event the Board of Directors concludes, by two-thirds vote, that the purposes herein set forth cannot be efficiently and adequately accomplished as herein contemplated by this corporation,

and, in case of such a decision, the Board of Directors may assign, transfer and convey all assets and property of the corporation to the Board of Regents of the State of South Dakota, or to its successor or successors, if any, to be managed, administered and conserved by said Board of Regents or its successor, for the use and benefit of the people of South Dakota, through the South Dakota State College. Such assignment, transfer and conveyance, may be in partial or total liquidation of this corporation as such Board of Directors may decide.

Article III Place of Business

The place where the principal business of this corporation shall be transacted is the City of Brookings, in the County of Brookings, State of South Dakota.

Article IV Term

The term for which this corporation shall exist shall be perpetual.

Article V Directors

The number of directors of this corporation shall be eleven and the names of the residences of those member who are to serve until the election of their successors are as follows:

<u>Names</u>	<u>Residences</u>
Lyman E. Jackson	Brookings, South Dakota
A. M. Eberle	Brookings, South Dakota
I. B. Johnson	Brookings, South Dakota
John V. Hepler	Brookings, South Dakota
W. W. Worzella	Brookings, South Dakota
U. J. Norgaard	Brookings, South Dakota
E. G. Sanderson	Aurora, South Dakota
Frank Swope	Orient, South Dakota
E. Fletcher	Garden City, South Dakota
Cole Burton	Piedmont, South Dakota
Frank Cundill	Isabel, South Dakota

Memorandum of Understanding Between SDSC and FSSD

Necessity For Development Work With Foundation Seed Stocks.

Newly developed strains of seed are released by the Agricultural Experiment Station in small quantities, just a few pounds of each new type. This stage marks the end of the experimental work in the Experiment Station. These few pounds must be increased under careful supervision to lots of 2,000 bushels or more before release to farmers of the state may begin with benefit to the whole state.

This development work is not experimental work but does require the supervision of Agronomy crop breeding and production specialists to prevent deterioration of the strain and consequent disrepute to the work of the College.

The development also requires flexible business management. The management must be in a position to act promptly in making contracts for growing seed and in handling other business matters as they come up, including the impartial distribution of seed when it is finally ready for distribution.

The development also requires state support. At least in its early stages this development work is not self-supporting. But it will be a direct and very great contribution to the agricultural income of the state and it is within the general purpose approved for the Division of Agriculture at State College.

Plan For Development Work

The plan that is used in other states and set up in South Dakota is a cooperative arrangement, between the College and a non-profit corporation. The College is to furnish the essential technical supervision and management and the corporation is to handle the business and to be self-supporting so far as is possible. At South Dakota State College the corporation is the Foundation Seed Stock Division of the South Dakota State College Foundation. The working arrangements to govern the cooperative efforts are stated in the following agreement:

Agreement for Cooperative Efforts

With and subject to the approval of the Regents of Education for the College and the Board of Directors for the Foundation, the essentials of the working agreement are as follows:

(1) The College will furnish, with reimbursement from the Foundation so far as the proceeds of the seed stock sales permit, the technical supervision and management necessary for the success of the development and may furnish where they are available growing plots and building space for the care of seed stocks.

(2) The Foundation will handle all contracts and business matters connected with the growth, storage, and sale of foundation seed stocks.

The Foundation will bind itself to use the proceeds of the sales to meet obligations assumed in the following order so far as the funds permit.

The first obligation shall be the cost of growing and caring for the various seed stocks by contract or otherwise. It will be considered reasonable and necessary for the Foundation to have a working fund of \$8,000 or thereabouts at the opening of each growing season in order to carry the work through that season.

The second obligation shall be the reimbursement of the College for salary costs, rental costs, and other actual expenditures made in support of Foundation seed development work. Such reimbursable costs shall be determined and itemized annually by the Head of the Agronomy Department, with the approval of the Dean of Agriculture, and shall be reported to the President of the College, and to the Board of Directors of the Foundation.

The obligation third in order of claim upon the proceeds shall be (a) building up of one to two years of reserve seed stocks, (b) equipment and facilities for special needs of this work, and (c) the building up and maintaining of reserve fund of at least \$15,000.00 for the purpose of carrying the seed stock development work through one or more unprofitable growing seasons.

After the obligations stated above have been fully met, the Foundation may use any surplus funds realized from the sale of Foundation seed for other projects which will be beneficial to the people of South Dakota, or to the work of the State College and which are within the purpose of the Foundation as approved in its Articles of Incorporation.

The Foundation shall keep an accurate and reasonably complete accounting system, and shall make an annual report to the President of the College showing reasonable itemization of receipts, expenditures, balances, and seed stock inventories. The Foundation shall have its accounts audited by a Certified Public Accountant at least once in five years.

(3) The adjustment of details in this cooperative effort shall be consistent with the general procedure described above and the objective of each party shall be to render service to the people of South Dakota. To facilitate smooth adjustment of details and purposes, the Foundation shall maintain on its Board of Directors as ex-officio members, the Head of the Agronomy Department, the Dean of the Division of Agriculture, and the President of the College. (The words "ex-officio members" were deleted in 1972).

APPROVED by the Board of Regents of Education of South Dakota May 15, 1946

/S/ W. E. Mumford

President

/S/ Mrs. E. R. Doering

Secretary

APPROVED by the Board of Directors, Foundation Seed Stock Division of the South Dakota State College Foundation.

July 24, 1946

/S/ W. W. Worzella

President

/S/ A. O. Syverud

Secretary

SEAL

Methods of Handling New Crop Releases
U. J. Norgaard

The state office has been asked to prepare outlines suggesting methods of increasing and distributing the new crop releases. We have learned that situations differ somewhat in the various counties which determine the exact method counties wish to use.

However, the plans used should include the following basic principles:

(1) The county association has the responsibility of selecting qualified growers of new releases.

(2) The growers assume the responsibility of growing and handling of crops according to seed certification standards.

(3) The grower gets a share of the crop increase and a price for increase seed which the association deems fair and equitable.

(4) The balance of seed left after the grower receives his share, shall be sold to the association members.

(5) The county association has the responsibility of controlling the distribution of the increase seed until a certain date (for spring planted crops we are suggesting January 15) and to establish a fair price. (The date was later changed to October 1).

(6) All association members and other farmers in the county must be informed about the closing date and have an opportunity to make application for the increased seed.

(7) Membership in a county association is open to any citizen in the county.

(8) Price established for increased seed is the same to members or non-members.

County crop improvement associations have a very important part in the program of increasing these new variety releases. Directors of County Associations are responsible for seeing that competent growers increase the Foundation seeds and that control of the distribution of

the increase is maintained. This means that the counties must operate in a business like manner. The plan or plans which an Association will use in distribution of these releases should be decided at a County Association meeting, which all members have been invited to attend. This is important.

Every Crop Improvement Association member has the privilege to make application to increase any of the new crop releases. However, the Board of Directors do have the responsibility of rejecting any application if they know that said grower does not have the adequate facilities to properly grow and handle the crop. The grower must comply to all seed certification standards and regulations and is responsible for all Certified seed he sells. In order to compensate him for the extra care needed in production of Certified seed, a reasonable premium should be awarded.

Every precaution should be taken to eliminate the hazards involved in the production of these valuable seeds. Numerous small fields have proven impractical. A field must be large enough so that the grower will have enough invested to warrant the extra attention that he must give in order to produce Certified seed. Small lots of seed are more subject to mechanical mixtures. Small isolated fields are also more subject to destruction by insects and livestock. Should a county lose its increase field through hail, insects or drought, arrangements can be made to take care of such cases from increases from other counties or from increase seed produced by the FSSD.

Before any of the new crop releases are allotted to the grower, a thorough understanding should be made of the plan and procedures in handling the increase. A written agreement prevents misunderstanding and helps all parties.

In order to meet emergencies that may arise, the FSSD, in releasing Foundation seed to County Crop Improvement Associations, reserves the right to recall all or any portion of any variety of seed released. This applies only to the seed produced from the original release obtained from the FSSD.

OPERATION OF FSSD

The FSSD began operation in 1944. Syverud planted 50 bushels of Vikota oats that had been obtained from the Regional Oats Committee. It was planted on 17 acres of the Agronomy Farm and produced over 2,400 bushels.

Seed Production and Processing

At first Foundation seed was produced on the Agronomy Farm, but that area was soon

outgrown. About 20 acres on the Sioux River about 9 miles south of Brookings were leased for corn production under irrigation. Other crops were raised under contract with experienced seed growers. At first they planted the seed, but the FSSD eventually acquired enough equipment to do the seeding and hauling to the processing plant. It also had a self-propelled combine which was used to do some of the harvesting.

In 1966 the 117 acres on the Moody County Farm located 11 miles south of Brookings on I-29 was assigned to the FSSD. This farm was used primarily for the planting of small lots of seed.

In order to process the seed, an army barracks and one or two round grain bins were located north of the football field. Other equipment included a fanning mill and grain elevator.

Within 5 or 6 years the volume of seed produced exceeded the capacity of the seed processing plant. The 1953 legislature granted a request to build a larger processing plant on state owned land at no expense to the state. The FSSD borrowed the money and constructed the plant at its present location. Syverud lived long enough to see the plant completed. The last installment on the loan was paid in 1959. Since that date several additions have been made (Chapter XIV).

Buildings were built and equipment purchased from income derived from the sale of Foundation seed. Income from the sale of corn seed was relatively stable but the income from other seeds fluctuated greatly, depending on the number of new varieties developed in the North Central states that were adapted to South Dakota conditions.

Income from corn inbreds and single crosses gradually increased as Sokota Hybrid Producers and other corn companies increased their seed acreage and as inflation rose. Income was around \$40,000 in the early 1960s and \$60,000 in the late 1970s, while income from other seeds fluctuated between \$50,000 and \$300,000 during the same 20-year period.

Expenses gradually increased from around \$70,000 in 1969 to twice that amount a decade later. Obviously net profit fluctuated--\$47,000 in 1969 and \$7,000 in 1979. During good profit years equipment was purchased and buildings erected. In addition, the FSSD made several grants--\$3,000 for wheat breeding in 1962, \$40,000 to help equip the physiology laboratories and greenhouses in 1971, \$5,000 to purchase equipment for plant breeding in 1975, \$15,000 to help build a field laboratory at Box Elder for the West River Research and

Extension Center in 1977 and \$1,000 for the national County Agents Association meeting in Rapid City in 1979.

Fiscal Year and Board Meetings

For almost 20 years the fiscal year was January 1 to December 30 and the annual meeting of the Board of Directors was held in January.

In 1961 the board voted to change the fiscal year to July 1 to June 30 which coincided with the fiscal year of SDSC. At Derscheid's suggestion, the board, in 1963, changed the meeting date to late October or early November. This allowed the board to pass judgment on varieties before Foundation seed of any variety was distributed. However, farmer members had to shut down corn harvesting operations and asked to have the meeting in early December. The date was changed in 1977.

Seed Distribution

Foundation seed was distributed to County Crop Improvement Associations, more or less on a first come first serve basis. Sometimes counties obtained seed that was not adapted to their areas and growers were disappointed when they did not obtain the yields they had expected.

In 1950 a seed allotment committee was established to allocate the seed (of newly released varieties) to county crop improvement associations (Weber). The committee included the Head of the Agronomy Department as chairman, the plant breeder(s) associated with the crop(s) being allocated, the Extension Agronomist, Manager of FSSD and Manager of Seed Certification Service. Later the Extension crops specialists played an active role in the allocation process.

Experience showed that the chances of mixture and loss due to mismanagement were smaller if several growers planted small amounts of seed than if one organization planted a large acreage. On the other hand, some growers would neglect the crop if the amount of seed were too small. Therefore, the allocation committee usually set the unit of allotment for each grower at the number of bushels needed to plant 15 to 30 acres.

The committee usually decided on the area of adaptation--Northeast, Western, All State, etc. The number of allotments to a county crop improvement association within the area of adaptation was proportional to the number acres of the crop raised in the county. Adjacent county groups received fewer allotments.

County crop improvement associations selected the growers in their counties. This sys-

tem proved to be an improvement over the methods previously used, but it still had some limitations. Seed was often offered to friends rather than seedsmen or growers who had the knowledge and desire to produce high quality seed. Seed was offered to Farmer A because Farmer B got the new variety last year. There was no continuity to continue with a good qualified grower (Weber).

Those who obtained seed would produce it for 1 or 2 years and then drop it because no one beat a path to their doors for the seed. As a result, the availability of the new seed variety through trade channels became almost nil. The seed source was the farmer's bin. Seedsmen were reluctant to pick up the pieces and promote the variety after the cream had been skimmed off the early sales (Weber).

The seed increase and release policy was changed several times. The first change occurred when Teton alfalfa was ready to be released. It seemed that the best way to increase seed of alfalfa was to grow it in Idaho's alfalfa seed producing area. SDCIA members were not well equipped to produce seed any place except their own farms. Therefore, a special agreement was developed with three South Dakota seedsmen to produce Foundation seed. They planted 400 acres with Breeders seed in 1958 for the production of Foundation seed in 1959. The FSSD purchased some of the Foundation seed and the seedsmen sold the rest as Certified seed.

In 1959 the seedsmen asked to be allocated Foundation seed of new varieties. Another agreement was developed in which 10% of the Foundation seed of a new variety was allocated to the South Dakota Seed Trade Association. A committee of the Association determined which members would plant the seed to produce Registered seed.

A significant change came in 1960 when the International Association of Official Seed Certifying Agencies (AOSCA) adopted "limited generations" as part of certification. Registered seed became more in demand and Certified seed became ineligible as a planting stock to produce additional generations of Certified seed. This practice was adopted in South Dakota in 1968. The amount of Foundation seed distributed increased substantially (Weber).

Since Foundation seed was extremely valuable, it was desirable to place it in the hands of highly qualified growers. Experience seemed to be the best qualification. It could not be obtained by producing seed every once in a while. Therefore, growers were classed as Group I, II or III based on the amount of experience in producing Certified seed. A

Group I grower was one who had completed certification each of the previous 3 years; a Group II grower was one who had completed certification 2 of the past 3 years; and a Group III grower one who has completed certification 1 of the past 3 years.

In July 1977, the SDCIA board of directors approved a new seed release policy.

Foundation seed of recommended new first year releases would first be allotted to Group I growers. After Group I growers had submitted their requests, the remainder of the seed would be allocated to county crop improvement associations for release of Groups II and III growers. The acreage of any class of Certified seed (except corn, sorghum, grasses and small-seeded legumes) grown the previous year would determine the number of basic allotments a Group I grower could receive--1 to 50 acres, 1 allotment; 51 to 100 acres, 2 allotments; and 101 and over, 3 allotments.

The amount of a basic allotment for any one variety for any one year would be adjusted according to the amount of Foundation seed available and area of adaptation. No Group I grower would receive no more than three basic allotments until all other qualified growers' requests had been filled or before the designated closing date for placing orders. Then additional requests could be honored if seed was still available.

County associations could request additional seed of new recommended varieties for Group II and III growers. The number of basic allotments to Group II and III growers by the county crop improvement associations would be allocated the same as for Group I growers.

Foundation seed of new varieties not being recommended by the Experiment Station would be made available to county crop improvement associations without specific county allotments. Qualified growers would have first priority and be given seed in order of classification.

Under this policy the Manager of the FSSD wrote a letter about Thanksgiving time to all Group I growers. He listed the varieties available and gave a brief description of each, price per bushel, and number of allotments each grower was eligible to receive. Those wishing seed were asked to submit their orders before Christmas. About half the seed of a new variety that was being recommended by Experiment Station and Extension personnel was allotted to Group I growers.

After Christmas the remainder of the Foundation seed of recommended varieties was al-

lotted to county crop improvement associations with a deadline of mid-February for ordering seed.

In mid-February the allotment committee made the final allocation. Seed allotted to counties that did not want it was allotted to counties that ordered more than originally allotted. Each county association was notified of the final allotment.

In 1973 the FSSD board approved the increase of seed developed by commercial companies. Foundation seed of two soybean varieties developed by Peterson Seed Co. was produced. To date other companies have not taken advantage of this service.

Another change took place in 1978 when Rebound smooth brome grass was released. Several perennial forage crops had been released earlier. Teton and Travois had been released to seedsmen and several grasses had been released to farmer-growers. By the mid-1970s, it was difficult to find Certified seed of any of them. Therefore, a new seed distribution policy was developed. The seed was given to a consortium of three seed companies that agreed to produce and market Certified seed of the variety and pay the FSSD a few cents royalty for every pound sold.

Varieties Distributed

Except for Siouxann (1951) and State Fair (1957) tomatoes, Chinkota Elm (1952), Siouxland Cottonwood (1954) and Manta foxtail millet (1958), the varieties developed in South Dakota are listed with the various crops in preceding chapters. The 84 cultivars include 16 corn hybrids and 50 inbred lines, 23 small grain and flax varieties, 9 alfalfa and grass varieties and 17 sorghum varieties and hybrids. The 200 varieties developed in other states or Canada and released to South Dakota growers through the FSSD are listed below:

Varieties developed by other states that were increased and distributed in South Dakota by FSSD.

<u>Variety</u>	<u>Crop</u>	<u>Year</u>	<u>State</u>
Koto	flax	1945	N. Dakota
Ottawa	soybeans	1945	Canada
Madarin	soybeans	1945	Wisconsin
Clinton	oats	1947	Iowa
Dakota	flax	1947	N. Dakota
Osage	oats	1947	Kansas
Ranger	alfalfa	1947	Wisconsin
Sheyenne	flax	1947	N. Dakota
Vernum	durum wheat	1947	N. Dakota
Minter	HRW wheat	1949	Minnesota
Hawkeye	soybeans	1949	Iowa
Moore	barley	1950	Wisconsin

Capital	soybeans	1950	Canada	Wyndmere	oats	1967	N. Dakota
Lee	HRS wheat	1951	Minnesota	Dawn	oats	1967	N. Dakota
Redwood	flax	1951	Minnesota	Portal	oats	1967	Wisconsin
Blackhawk	soybeans	1951	Iowa	Jaycee	oats	1967	Illinois
Marine	flax	1952	Minnesota	Polk	HRS wheat	1968	Minnesota
Nugget	durum wheat	1952	N. Dakota	Kelsey	oats	1968	Canada
Piper	sudangrass	1952	Wisconsin	Sioux	oats	1968	Canada
Clintafe	oats	1953	Iowa	Nored	flax	1968	Minnesota
Selkirk	HRS wheat	1954	Canada	Corsoy	soybeans	1968	Iowa
Chippewa	soybeans	1955	Illinois	Clay	soybeans	1968	Minnesota
Traill	barley	1956	N. Dakota	Dawson	alfalfa	1968	Nebraska
Yuma	durum wheat	1956	N. Dakota	Guide	HRW wheat	1968	Nebraska
Conley	HRS wheat	1956	N. Dakota	Scout 65	HRW wheat	1968	Nebraska
Grant	soybeans	1956	Minnesota	Trapper	HRW wheat	1968	Nebraska
Empire	birdsfoot trefoil	1956	Iowa	Trader	HRW wheat	1968	Nebraska
Vernal	alfalfa	1956	Wisconsin	M 68	oats	1969	Iowa
Ransom	oats	1956	N. Dakota	E 68	oats	1969	Iowa
Narragansett	alfalfa	1956	Rhode Isl.	Norstar	flax	1969	Minnesota
Ramsey	durum wheat	1957	N. Dakota	Noralta	flax	1969	Canada
Nordan	crested wheatgrass	1957	N. Dakota	Waldron	HRS wheat	1969	N. Dakota
Minhafer	oats	1958	Minnesota	Panhandle	proso millet	1969	Nebraska
Bolley	flax	1958	N. Dakota	Pettis	oats	1969	Missouri
Burnett	oats	1958	Iowa	Foster	flax	1969	N. Dakota
Ford	soybeans	1958	Iowa	Neepawa	HRS wheat	1970	Canada
Dollard	red clover	1958	Wisconsin	Hercules	durum wheat	1970	Canada
Goldtop	sweetclover	1958	Wisconsin	Linott	flax	1970	Canada
Vinall	Russian wildrye	1958	N. Dakota	Otter	oats	1970	Minnesota
Arny	flax	1959	Minnesota	Rampage	soybeans	1970	Iowa
Lindarin	soybeans	1959	Indiana	Wirth	soybeans	1970	Iowa
Clintland 60	oats	1960	Indiana	Anoka	soybeans	1970	Minnesota
Wells	durum wheat	1960	N. Dakota	Froker	oats	1971	Wisconsin
Lakota	durum wheat	1960	N. Dakota	Nodaway 70	oats	1971	Missouri
Pembina	HRS wheat	1961	N. Dakota	Cayuse	oats	1971	New York
Canthatch	HRS wheat	1961	Canada	Fletcher	HRS wheat	1971	Minnesota
Trophy	barley	1962	N. Dakota	Protana	soybeans	1971	Indiana
Larker	barley	1962	N. Dakota	Dunn	soybeans	1971	Wisconsin
Dodge	oats	1962	Wisconsin	Amsoy 71	soybeans	1971	Iowa
Bonkee	oats	1963	Iowa	Centurk	HRW wheat	1971	Nebraska
Neal	oats	1963	Nebraska	Trio	oats	1972	Nebraska
Windom	flax	1963	Minnesota	Nordic	barley	1972	N. Dakota
Justin	HRS wheat	1963	N. Dakota	Swift	soybeans	1972	Minnesota
Hawkeye 63	soybeans	1963	Iowa	Rolette	durum wheat	1927	N. Dakota
Hawkeye 63	soybeans	1963	Illinois	Otee	oats	1973	Illinois
Crim	HRS wheat	1964	Minnesota	Dal	oats	1973	Wisconsin
Lodi	oats	1964	Wisconsin	Ward	durum wheat	1973	N. Dakota
Chippewa 64	soybeans	1964	Illinois	Steele	soybeans	1973	Minnesota
Lindarin 63	soybenas	1964	Indiana	Wells	soybeans	1973	Illinois
Clintland 64	oats	1965	Indiana	Snowbird	proso millet	1973	Minnesota
Tippecanoe	oats	1965	Indiana	Beacon	barley	1973	N. Dakota
Brave	oats	1965	Illinois	Rymin	winter rye	1973	Minnesota
Santee	oats	1965	Nebraska	Kodiak	winter rye	1973	Canada
Chris	HRS wheat	1965	Minnesota	Olaf	HRS wheat	1974	N. Dakota
Dickson	barley	1965	N. Dakota	Noble	oats	1974	Indiana
Lancer	HRW wheat	1965	Nebraska	Nowesta	HRS wheat	1974	Priv. N.D.
Tyler	oats	1966	Indiana	Sage	HRS wheat	1974	Kansas
Clintford	oats	1966	Indiana	Puma	winter rye	1974	Canada
Orbit	oats	1966	New York	Rugby	durum wheat	1974	N. Dakota
Sheridan	HRS wheat	1966	Montana	Botno	durum wheat	1974	N. Dakota
Manitou	HRS wheat	1966	Canada	Crosby	durum wheat	1974	N. Dakota
Amsoy	soybeans	1966	Iowa	Buckskin	HRW wheat	1974	Nebraska
Leeds	durum wheat	1967	N. Dakota	Baca	HRW wheat	1974	Colorado
Fortuna	HRS wheat	1967	N. Dakota	Hodgson	soybeans	1974	Minnesota
Hark	soybeans	1967	Iowa	Astro	oats	1975	New York
Holden	oats	1967	Wisconsin	Evans	soybeans	1975	Minnesota
O'Brian	oats	1967	Iowa	Woodworth	soybeans	1975	Illinois

Cerise	proso millet	1975	Nebraska	Marathon	oats	1979	Wisconsin
Harlon	soybeans	1976	Canada	James	HRS wheat	1979	S. Dakota
Wright	oats	1976	Wisconsin	Len	HRS wheat	1979	N. Dakota
Hodgson	soybeans	1976	Minnesota	Vic	durum wheat	1979	N. Dakota
Lindon	HRW wheat	1976	Colorado	Wells II	soybeans	1979	Nebraska
Rall	HRW wheat	1976	Oklahoma	Hodgson 78	soybeans	1979	Minnesota
Agate	HRW wheat	1976	Nebraska	Culbert 79	flax	1979	S. Dakota
Lang	oats	1977	Illinois	Wishek	flax	1979	N. Dakota
Lyon	oats	1977	Minnesota	Centurk 78	HRW wheat	1979	Nebraska
Butte	HRS wheat	1977	N. Dakota	Bennett	HRW wheat	1979	Nebraska
Cando	durum wheat	1977	N. Dakota	Corsoy 79	soybeans	1980	Illinois
Harcor	soybeans	1977	Canada	Weber	soybeans	1980	Iowa
Coles	soybeans	1977	Iowa	Nebsoy	soybeans	1980	Nebraska
Dufferin	flax	1977	Canada	Vickery	soybeans	1980	Iowa
Roughrider	HRW wheat	1977	N. Dakota	Century	soybeans	1980	Indiana
Vona	HRW wheat	1977	Colorado	Will	soybeans	1980	Illinois
Bates	oats	1978	Nebraska	Gnome	soybeans	1980	Ohio
Sloan	soybeans	1978	Iowa	Cottonwood	bromegrass	1980	S. Dakota
Coteau	HRS wheat	1978	N. Dakota	Retain	creeping foxtail	1980	S. Dakota
Angus	HRS wheat	1978	Minnesota	Rita	HRW wheat	1980	S. Dakota
Eureka	HRS wheat	1978	S. Dakota	Dawn	HRW wheat	1980	S. Dakota
Edmore	durum wheat	1978	N. Dakota	Tam 105	HRW wheat	1980	Texas
Calvin	durum wheat	1978	N. Dakota	Ogle	oats	1981	Illinois
Park	barley	1978	N. Dakota	Larry	oats	1981	Illinois
Glenn	barley	1978	N. Dakota	Pondera	HRS wheat	1981	Montana
Morex	barley	1978	Minnesota	Hardin	soybeans	1981	Iowa
Lancer	oats	1979	S. Dakota	Sprite	soybeans	1981	Ohio
Moore	oats	1979	Minnesota	Rose	HRW wheat	1981	S. Dakota
Benson	oats	1979	Minnesota	Nell	HRW wheat	1981	S. Dakota



G.W. Erion examining seed reserves kept in germ plasm preservation chamber of all varieties developed in South Dakota.



Foundation seed, processed and sacked--ready for SDCIA members who will produce Registered seed for Certified seed producers.

CHAPTER XXXIV PERENNIAL WEED INVESTIGATIONS

Problems caused by weeds were mentioned in several early Experiment Station bulletins by agriculturists and botanists. The first weed research was conducted in 1908, additional work was done in 1926 and the 1930s, but the Experiment Station reached its 60th birthday before weed control research became a permanent activity.

PERSONNEL

Staff Members

A. L. Bushey	1926-?
C. J. Franzke	1930-1936
E. L. Erickson	1939-1946
Dr. L. M. Stahler(USDA)	1946-1950
Dr. L. A. Derscheid*	7/47-6/64

D. E. Kratchovil (50%)	1/48-3/51
J. H. Miller (50%)	8/47-1/48
W. H. Wallace	1960-1962
Dr. L. R. Warner	1962-1964
Dr. John Dosland	1962-1968

W. G. Wright	1964-1966
Dr. Jimmy Stritzke*	1965-1969
C. E. Stymiest	9/68-1/70
Dr. W. E. Arnold*	1970-

W. B. O'Neal	1970-1974
M. A. Wrucke**	1977-
R. L. Smith**	1980-
M. A. Peterson**	1980-

Graduate Students

Lyle A. Derscheid	M.S.	3/1946-6/1947
Donald E. Kratochvil	M.S.	** 3/1951
James R. Hay	M.S.	1948-1950
Keith E. Wallace	M.S.	8/1952-6/1954
Russel L. Nash	M.S.	7/1954-6/1956

Gail A. Wicks	M.S.	7/1956-6/1958
Robert E. Schultz	---	9/1956-11/1957
Sam Zilke	Ph.D.	12/1956-6/1968
Wilford H. Wallace	M.S.	9/1958-6/1960
W. E. Splittstoesser	M.S.	7/1958-6/1960

Robert Anton	---	1958-1959
Charles A. Beasley	Ph.D.	9/1960-10/1963
Leon J. Wrage	B.S.	7/1961-6/1964
James D. Arnold	M.S.	1964-1966
James F. Peacock	Ph.D.	1967-1970

Claire E. Stymiest	M.S.	** -1970
William B. O'Neal	M.S.	** -1974
Bart A. Brinkman	M.S.	1971-1974
Steven E. DeHoogh	M.S.	1974-1976
Jeffrey M. Tichota	M.S.	5/11/74-5/1/76
Randall L. Anderson	M.S.	1974-1976
James A. Behm	M.S.	1974-1977

Duane E. Auch	M.S.	1975-1977
Jay Holmdahl	M.S.	7/78-
T. V. Keith	M.S.	1978-1980
K. H. Khedir	Ph.D.	1980-
J. C. Klauser	Ph.D.	1980-
P. E. Todt	M.S.	1980-

*Project Leader

**Full-Time assistants when taking graduate work

Alfred L. Bushey, Clifford J. Franzke and Elmer L. Erickson had other responsibilities besides weeds. Lyle A. Derscheid worked half-time with weeds from March 1946 to July 1947, full-time until March 1, 1960. In August of 1947 a graduate assistantship in weeds and another in teaching were used to hire John H. Miller as an assistant on a half-time basis. In December Miller joined the USDA as weed researcher in Minnesota and Donald E. Kratochvil took his place on January 1. When Kratochvil finished work on an M.S. degree in 1951, he also joined the USDA as a weed researcher in North Dakota.

For the next 8 years Derscheid was assisted by graduate students, undergraduate students and high school students.

Derscheid became half-time Extension Agronomist in 1960, Wilford H. Wallace was employed as Assistant Agronomist to aid with the weed research, and was succeeded in turn by Lloyd R. Warner, Wayne G. Wright and Clair E. Stymiest. In 1969 this position was downgraded to "Assistant in Agronomy", which was a full-time position for a person with a B.S. degree that enrolled in graduate school.

Derscheid was succeeded as project leader in 1965 by Jimmy Stritzke, who in 1970 was replaced by W. Eugene Arnold.

Like most projects, the work was done by the staff members during the early years. Franzke had assistance from the foreman of the substations and the Agronomy Farm.

During the 1950s, Derscheid did the seeding and was present for all spraying operations, all weed counting and corn picking. However, students who were farm boys were employed to do most of the plowing, disking, cultivating, mowing and small grain harvesting. From two to four undergraduates and/or high school students were employed full-time during the summer and part-time during the school year. Some of them worked all through college and served as "straw bosses" during their junior and senior years. Duane Stuerman, a Brookings resident, worked for 7 years while in high

school and college. As many as six or eight others were sometimes employed on Saturdays during the school year to make weed counts, harvest corn yield samples or lay out plots on new experiments.

Some of those who worked a year or more were Arnold Walz, Elton (Jerry) Budahl, Fred Engel, Milo Stoscheim, Marvin Peterson, Andrew Nelson, Everett (Eddy) Bergerson, Roger Denker, Russel Maxwell, Donald Broksieck, Duane Stuerman, Clarence (Butch) Griep, Herbert (Killer) Killam, Kenneth Keppler, Donald Larson, Leon Wrage, Harlan Palm and Clair Stymiest.

QUACKGRASS

In 1916 A. N. Hume wrote about quackgrass. He said, "Quackgrass possesses rootstalks of a distinctly brownish yellow color. This color helps distinguish it from other grasses, that also possess rootstalks" (Bul 170).

"Any method of eradicating quackgrass must prevent leaf growth and destroy the rootstalks. Methods of destruction include hand digging, summer fallowing and tarred paper mulching" (Bul 170).

"July and August cultivation is more effective than cultivation at any other time . . . The cost of continued cultivation all summer is \$15.00 per acre. A cultivated crop after summer fallowing is a logical final step . . . Corn when employed for such purposes should be cultivated to a slightly greater depth than would otherwise be advisable and cultivators should be equipped with broad 'scoop' shovels with sharp cutting edges" (Bul 170).

CHEMICALS FOR BINDWEED CONTROL

A. L. Bushey, soils analyst, in 1926 treated 4-square-yard plots of field bindweed on plot 144 of Agronomy West Farm with several chemicals in an attempt to control the weed. Chemicals were applied with a knapsack sprayer. Those that were soluble in water were mixed in several concentrations and applied in 50 gallons of solution per acre. Treatments were made on May 29, June 12, June 30, August 5, August 23 and September 22 (Bul 305).

All bindweed plants were killed when sprayed three times (June 30, August 5 and September 22) with a 10% solution of potassium chlorate. Most plants were killed by spraying three times with a 7% solution of potassium chlorate and 5, 7 or 10% solutions of sodium arsenite. Fair kill was achieved with six applications of 7 to 10% solutions of sodium dichromate, and three sprayings with 7 or 10% solutions of calcium chlorate. Lower concentrations of these chemicals were ineffective as were all treatments with aluminum chloride, potassium

permanganate, ethyl gasoline, cylinder oil and cyanamid (Bul 305).

LATER FIELD BINDWEED RESEARCH

C. J. Franzke conducted research on the use of summer fallow at Brookings, mulch paper at Highmore, Cottonwood and Eureka, sodium chlorate at Eureka and Brookings and several competitive crops for the control of field bindweed. In 1936 he and A. N. Hume reported the results.

Fallow

They concluded that the weed could be eradicated by fallowing if done correctly. Two systems had been effective. On the East Agronomy Farm at Brookings, plots had been hand hoed ten times at daily intervals, ten times at 2-day intervals, fifteen times at 3-day intervals, seven times at 4-day intervals and twice at 7-day intervals for a total of 44 hoeings between June 19 and October 5, 1933. The next year they were hoed eleven times at 5- to 7-day intervals before July 7. Though bindweed plants were weak at the beginning of the second season, at least one plant remained active until the tenth operation on June 28, 1934. There was no regrowth when examined in June 1935 (Bul 305).

Plowing with a 2-horse walking plow at 5-day intervals during the early part of 1927 and every 9 days during the latter part of the season reduced the bindweed stand at Highmore, but it was necessary to repeat the treatments in 1929 to eliminate the stand (Bul 305).

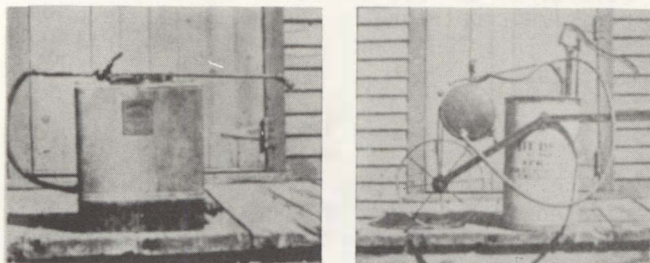
Competitive Crops

In another experiment each of several crops was planted in 1934. They were harvested in 1935 and the area for each was fallowed until a crop of winter rye was seeded. The crops grown in 1934 and per cent bindweed survival after 1935 were winter rye 2.2%, wheat 4.4%, oats 7.6%, barley 8.2%, foxtail millet 30.9% and proso millet 35.5%. Areas fallowed the entire season of 1935 and seeded to winter rye had 1% survival. An area solid-seeded to sudangrass in 1935 and harvested just before seeding winter rye had 79.4% survival. There was not enough moisture for two successive crops and they were not competitive (Bul 305).

Chemicals

After small grain had been harvested on the West Agronomy Farm in 1933, C. J. Franzke and Leo F. Puhr applied several chemicals in 100 gallons of spray per acre for field bindweed control. Two applications of commercial chlorates at 1 1/2 and 2 pounds per gallon reduced bindweed stands 23 and 38% respectively. How-

ever, two applications of 1 to 15% solutions each of sodium thi-sulfuric acid, sulfurous acid, sodium hypo-chlorite and calcium hypo-chlorite, 5 to 10% solutions of copper sulphate and one application of 2 to 8 tons per acre of slaked lime and limestone were ineffective (Bul 305).



Plot sprayers used in 1930s.

Two pounds per gallon of commercial chlorates applied Oct. 21, 1932 in 75 gallons of water per acre completely eliminated the weed, but a similar treatment a year later was ineffective (Bul 305).

INTRODUCTION OF 2,4-D

Elmer L. Erickson had charge of the weed research program from 1939 to 1946. However, he also was responsible for the operation of the Seed Testing Laboratory and forage crop research. He taught a course in seeds and weeds and produced a series of weed seed identification plates. Though he did very little research on weed control, he may have been one of the first to apply 2,4-dichlorophenoxyacetic acid (2,4-D) for weed control in South Dakota. He applied several rates of several 2,4-D formulations to dandelions growing on the SDSC campus mall in 1945.

BEGINNING OF NEW ERA

During a discussion of the weed problem in South Dakota at a December 1934 meeting of the board of directors of the South Dakota Crop Improvement Association, director Henry Preheim moved a resolution, "that the board of directors of the SDCIA are in favor of starting a Creeping Jenny (Field Bindweed) Experimental and Demonstrational Farm in Southeast South Dakota and that the association use some of its funds, if that is possible, to start such a project; and further that a copy of this resolution be sent to South Dakota State College and other interested agencies, seeking their cooperation, looking toward a united effort in order to start a sound program directed against this weed pest" (JW-39).

This was during the depth of drought and depression and legislative appropriations for

SDSC were extremely meager. There was not enough money to maintain existing programs; consequently, there was no way of financing such a project at that time.

The SDCIA started to promote a new state weed law in 1941; but made little headway until its meeting on August 31, 1944. At that meeting President E. G. Sanderson presented the need for a concerted effort to control and eradicate weeds. The board voted to sponsor a new weed law at the next legislative session (JW-50).

The State Weed Law was passed by the 1945 Legislature. It created a State Weed Board, specified who the members would be, and authorized it to appoint a state weed supervisor. The State Weed Board was charged with the responsibilities of formulating the state weed program, of naming the noxious weeds and of determining methods of controlling those weeds. The responsibility of the board was primarily that of organization, while responsibilities were given to the Agronomy Department for research, to the Extension Service for education, and to the S.D. Department of Agriculture for law enforcement. Though no money was appropriated for implementation of the Law, it was understood that an appropriation would be made by the 1947 legislature.

Dr. W. W. Worzella, Head of the Agronomy Department, started to "gear up" for the time when money would be available. He requested that the USDA transfer Dr. Leonard (Chuck) M. Stahler to SDSC when the Bindweed Research Farm, that he had been supervising, at Lamberton, Minnesota, was closed. Stahler was transferred sometime in late 1945 or early 1946. Together they made plans to establish a Field Bindweed Research Farm in Southeast South Dakota as had been suggested by the SDCIA in 1934. Stahler would bring the USDA equipment from Lamberton and Worzella would provide some operational funds and a research assistant to operate the farm.

Lyle A. Derscheid was appointed as graduate research assistant on March 16, 1946 and a suitable site for the farm was located near Scotland, S.D., the area where the first field bindweed infestation occurred in the state, later that month.

The 1947 legislature appropriated money to implement the State Weed Law. The appropriation was made to the State Weed Board, a practice that was followed for a decade, but \$20,000 were earmarked for the Agronomy Department to use in a weed research program, \$10,000 to the Extension Service to hire a weed specialist, \$10,000 for the Department of Agriculture for law enforcement and an additional amount for the State Weed Board to use

for salaries of a state weed supervisor and one assistant and for operation of the organizational aspects of the weed program.

Derscheid finished the course work for an M.S. degree in one calendar year and was appointed Assistant Agronomist, in charge of the weed research project on July 1.

FIELD BINDWEED RESEARCH FARM 1946-1950

A lease, dated April 6, 1946, was signed by Tom Voy, and the South Dakota Agricultural Experiment Station. It provided that the Experiment Station could use 25 acres of the NW 1/4 of NW 1/4 of Sec 6, T 96N, R 58W, to conduct research on field bindweed, until March 1, 1951. It was to pay cash rent of \$5.00 per acre per annum on June 1 each year, and have the option to rent for another 5 years after 1951. A supplemental lease was signed September 27, 1947 which allowed Voy to claim any salvage from crops not needed for experimental purposes if he would do the harvesting.

Derscheid lived in Scotland from May 11 to September 14, 1946, and did most of the plot work. La Verne Williams, the high school coach, was hired for \$6.50 a day for about 2 weeks in 1946. He was hired to operate the farm for \$155 a month from June to August in 1947 and for \$175 per month for the same 3-month period in 1948. Arnold W. Walz, an agronomy student from nearby Menno, was hired for \$165 a month during summer vacation in 1949 and for \$175 per month in 1950.



Derscheid taking notes on Field Bindweed Research Farm in 1946.

A 1500-bushel grain bin, used for the federal Ever Normal Granary program, was purchased for \$15 in 1946 for storing small equipment and supplies.

A series of 3- and 4-year experiments were conducted on duplicate 1/10-acre plots. Identical experiments were initiated in 1946, 1947 and 1948 and completed in 1948, 1949 and 1950, respectively.

At first the work was largely devoted to testing cultural methods developed by weed researchers in Kansas, Iowa and Minnesota. However, 2,4-D was available and methods of using it were tested rather extensively.

The results showed that 95 to 100% elimination of the weed could be achieved in 1 year with intensive cultivation. The most practical system included eight operations, at a 4-inch depth with a field cultivator equipped with overlapping sweeps at 2-week intervals during June and July and 3-week intervals during August and September.

Summer Crops

Other results showed that three spring cultivations with a duckfoot cultivator; followed by a close-seeded crop of forage sorghum, soybeans or sudangrass that was harvested for forage; and another cultivation in the fall reduced bindweed stands and resulted in complete elimination of established plants when continued for 3 years.

Forage sorghum and sudangrass were very effective, but sorghum was faster--it reduced weed stands as much in 2 years as sudangrass did in 3 years. Close-drilled soybeans were also very effective when a good stand was obtained. Remaining bindweed plants appeared to be very weak. Millets were much less effective. Although the weed stand was reduced, the remaining plants were quite vigorous.

Perennial Crops

In three 4-year experiments bindweed was cultivated at a 4-inch depth every 2 weeks during June, July and early August. On August 15, alfalfa and several perennial grasses were seeded alone and in legume-grass mixtures.

Alfalfa and alfalfa-grass mixtures reduced the bindweed stand about 95% in 4 years while the sod-forming grasses only reduced the stand 65 to 70% and crested wheatgrass, a bunch grass, was less effective.

In two 3-year experiments, 2,4-D was applied to spring-seeded smooth brome grass. The grass was seeded in April and sprayed with 2,4-D amine during mid-June the first, second, or first and second year. In another experiment, three cultivations were performed during the summer, 2,4-D was applied in early August, followed by a seeding of brome and alfalfa in late August.

Spraying brome with 2,4-D each of 2 years reduced the stand about 95% in 3 years while spraying only 1 year was less effective. Intensive cultivation followed by an application of 2,4-D shortly before planting alfalfa or brome was less satisfactory. It appeared that residual herbicide may have damaged the crop. A poor stand apparently was not strongly competitive.

Crop Rotation

2,4-D was applied once a year for 3 years in continuous oats and in an oat-corn-oat rotation. With continuous oats, the bindweed stand was reduced 35% in 1 year, 60% in 2 years and 75% in 3 years. Stand reductions in the oat-corn-oat rotation were 35, 45 and 60% at the end of 1, 2 and 3 years.

Rates and Dates of 2,4-D

In duplicate square-rod plots, the butyl ester and sodium, ammonium and alkanol amine salts of 2,4-D were applied at four rates when bindweed was in each of three stages of growth in 1946. These tests were repeated in 1947 and 1948 with some modification of rates. Also an ester of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) was used in 1948.

Ester forms of 2,4-D and 2,4,5-T gave quicker top kill than the 2,4-D salts. However, the salts gave better root kill and higher percentage of elimination. It appeared that the esters were absorbed so rapidly that high concentrations inside the plant were toxic to the living phloem cells and the herbicide was not translocated to the roots. The salts, on the other hand, were absorbed more slowly and lower concentrations did not kill the phloem. They were translocated to the roots and were more toxic to the plant as a whole. A rate of 3/4 pound acid equivalent per acre appeared to be the optimum rate for the 2,4-D salts. They were more effective when applied to growth in early spring and least effective when the weed was in full bloom.

Commercial Formulations of 2,4-D

In 1946 a total of 17 commercial formulations (12 sprays and 2 dusts) were applied to duplicate square-rod plots at three concentrations. All ester sprays performed in a similar manner and gave quicker top kill than the salt sprays which in turn gave a quicker top kill than the dusts. The dusts were more difficult to apply and were less effective than the sprays.

Station Closed

Farmer Field Days were held in 1946, 1947 and 1949. The farm was discontinued in 1950 and the storage shed was sold to Tom Voy.

RESEARCH PLOTS 1947-1950

After La Verne Williams was hired to do the plot work on the Field Bindweed Research Farm, Derscheid had time to do other things. In 1947 he asked county agents to locate patches

of noxious weeds on private farms where he could test 2,4-D for its effectiveness in controlling several species of noxious weeds. The 14 sites located by the county agents ranged in location from Vermillion and Elk Point in the southeast; Wilmot, Twin Brooks and Sisseton in the northeast; Ipswich and Aberdeen in the north central and Pierre in the central part of the state.

At each location ester, amine and sodium salt formulations were each applied at three rates on duplicate square-rod plots. The two unsprayed plots brought the total to 20 plots at each location. A few cc's of chemical were mixed in 1 quart of water, equivalent to 40 gallons per acre, for each plot. Spraying was done with a knapsack sprayer equipped with a single nozzle. Field bindweed was sprayed at ten locations, Canada thistle a three and perennial sowthistle at Groton.



Spraying perennial sowthistle with knapsack sprayer in 1946.

Plots treated in 1947 were evaluated and retreated in 1948. Ten more experiments were established in which 2,4-D formulations were compared with 2,4,5-T and 2-methyl-4-chlorophenoxy acetic acid (MCPA) on field bindweed at Rapid City, Spearfish and Cottonwood; on Canada thistle at Nemo, Nisland and Cottonwood; bur ragweed at Belle Fourche; and prickly pear at Wicksville. Japanese chess was treated with trichloroacetic acid (TCA) and other grassy weed herbicides at the Cottonwood Substation.

All of the two dozen experiments were evaluated in 1949 and many of them retreated; consequently, few new experiments were initiated. Russian knapweed was treated at Wessington and Belle Fourche, Quackgrass at Aurora and leafy spurge at Arlington.

Kratchovil left in 1951 and was not replaced. Except for wild oats experiments in the late 1950s, this program was suspended for about a decade. Derscheid concentrated his studies on the perennial weed research farms, an 8-acre weed farm in the Horticulture Farm at Brookings, and aerial application of herbicides.

From 1955 to 1960, this included the 30-acre Leafy Spurge Research Farm, the 25-acre Thistle Research Farm, the 12-acre Russian

Knapweed Research Farm and the 8-acre farm at Brookings. Since plot size ranged from 1/2 square rod to 5 square rods in size, these farms included thousands of plots.

EQUIPMENT AND TECHNIQUES 1946-1950

In 1946 all the equipment available for weed research was owned by the USDA. It included a 1937 model B John Deere tractor with rear-mounted, 5-foot mower and 2-row cultivator, a two 14-inch bottom, pull-type John Deere plow and a 7-foot, pull-type John Deere field cultivator equipped with nine 12-inch duckfoot shovels mounted on three gangs. Horse-drawn equipment that had been modified for use with a tractor included an 8-foot grain drill, an 8-foot grain binder, a 7-foot Roderick Lean disk harrow and a 4-section, 20-foot, spike-tooth harrow. Small plot equipment included two or three Army surplus knapsack sprayers.

This equipment was used on the Field Bindweed Research Farm. Pull-type equipment was not adapted for small plot work; consequently, the plots were large--2 rods wide and 8 rods long with a 2-rod roadway between ranges of plots to turn around in. Ten plots and adjacent roadways covered 1 1/4 acres.

A trailer sprayer built by Fargo Foundry of Fargo, N.D., was borrowed in 1946 by Derscheid and Stahler to spray field bindweed in two small grain fields. One field, owned by Metropolitan Life Insurance Company, was located 6 miles east of Scotland and the other by Tom Voy, was adjacent to the Field Bindweed Research Farm.

The next year a Peavey Company representative brought a specially built sprayer to South Dakota. It had two small spray tanks which could be used separately. Two spray solutions could be mixed at one time, which saved considerable time. Plots in three replicates were sprayed while working away from the mixing point. Three others were sprayed with the other spray solution on the return trip. At that time, Derscheid decided to have a similar sprayer built.

For the 1947 county research plots, Derscheid hauled chemical, cans of water, a knapsack sprayer, hundreds of wooden stakes to mark the plots, a hammer and tape measure in the trunk of his car.

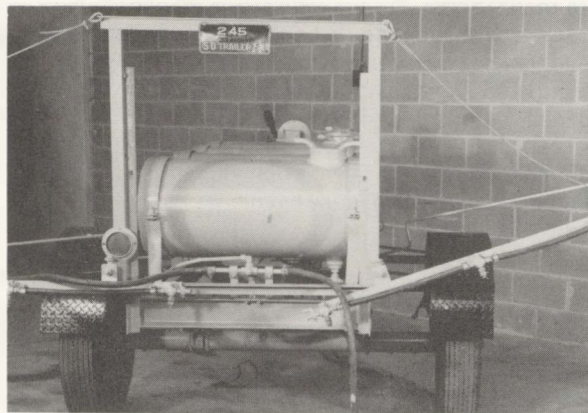
State funds from a 1947 legislative appropriations were available for purchasing equipment in 1948. A 6-foot, horse-drawn drill, modified for use with a tractor, was obtained for \$25 from the Eureka Substation for use on the Field Bindweed Research Farm.

A 1948 6-cylinder Ford pickup truck was obtained for \$1,075 and a 2-wheel Ben Hur trailer for \$135. Covered wooden boxes were built for both.

The pickup was available for use on the county research plots and D. E. Kratchovil was on the staff. A 4-nozzle boom was attached to the knapsack sprayer. Nozzles were spaced 2 feet apart to spray an 8-foot swath. A quart of spray could be uniformly applied by walking twice across a 16- X 16-foot plot.

Sodium chlorate, Atlacide and Borascu and some newer soil sterilants were applied to plots in some counties. They were not readily soluble in water and were applied dry. Applications were made by hand.

Also in 1948, the Fargo Foundry built a 2-wheeled, rubber-tired trailer sprayer for \$567. It was equipped with four 22-gallon iron spray tanks, an auxillary Briggs-Stratton motor, an Oberdorffer bronze gear pump, a speedometer and a 2-section, 16 1/2-foot boom equipped with 10 fan nozzles spaced at 20-inch intervals. The boom sections, attached with hinges, could be folded forward on either side of the sprayer when being towed on the highway.



Two-wheel sprayer purchased in 1948.

The USDA in 1948 or 1949 purchased a model H Farmall tractor and "tumble-type" 2-bottom plow, making it possible to turn furrows in opposite directions on alternate trips across the plot with no dead furrow to influence research results.

When the Field Bindweed Research Farm was closed, the equipment was moved to Brookings and then to the Leafy Spurge Research Farm.

A 1 1/2-ton truck, belonging to the Farm Service Department and a small flatbed trailer, built by the forage crop breeders for transporting a plot seeder, were borrowed to move most of the machinery the 185 miles. However, the Farmall tractor, which had a road

speed of 18 miles per hour, was driven to Brookings and towed behind a pickup to the Leafy Spurge Farm. The field cultivator was towed behind the tractor to Brookings. The next spring the John Deere tractor, which had a top speed of 6 miles per hour, was towed with a specially built tow bar behind the Farmall to the Leafy Spurge Farm.

LEAFY SPURGE FARM 1950-1956

Experiments conducted in various parts of the state from 1946 to 1949 indicated that 2,4-D was equal to or superior to 2,4,5-T, MCPA and several related chemicals for controlling leafy spurge. The ester forms of 2,4-D were more readily absorbed than amine forms. Leafy spurge reacted to small amounts of the herbicide, but the stand was not materially reduced by 2 or 3 treatments in 1 year with relatively high rates. Although the weed was easily affected by the chemical, it was quite resistant. It appeared that the weed could be weakened with 2,4-D so that a crop could compete more effectively with it or that cultivation could kill it more readily.

Since the work on the Field Bindweed Research Farm was drawing to a close, plans were made to establish a Leafy Spurge Research Farm and operate it with the equipment from the bindweed farm. A suitable site was located in Deuel County. Most of a 400-acre farm in the Pir Nilson estate was infested with leafy spurge that had been introduced to the farm when a threshing separator was moved from Indiana in 1918.

Thirty acres of the NE 1/4 of NE 1/4 of Sec 36, T 116N, R 47W, located 18 miles northeast of Clear Lake, was leased for 5 years with an option for a second 5 years. The rent was \$5 per acre per annum plus salvage from crops not needed for experimental work.

An old single-car garage (approximately 10-by 14-feet) was purchased in Brookings in 1951, and moved to the farm for storing a tractor, small equipment and supplies.

Approximately one-third of the farm was divided into plots in 1950, a second third in 1951, and the remainder in 1952. Four general types of experiments were conducted: (1) 3-year trials involving the use of annual crops, cultivation and 2,4-D; (2) 3-year trials involving the use of perennial crops, cultivation and 2,4-D; (3) comparisons of soil sterilants applied at several rates and dates for eliminating small patches; and (4) 1-year tests in which new chemicals were screened for possible use on large infestations.

Competitive, Crops, Cultivation and 2,4-D

A 3-year experiment involving the use of annual crops (winter rye, oats, sudangrass and buckwheat), intensive cultivation and 2,4-D was initiated during the fall of 1950 on duplicate 1- X 5-rod plots. Weed counts were made on 4 one-square-yard areas of each plot during the middle of May each year. The final counts were made in May, 1954. Identical 3-year experiments were initiated in August 1951 and 1952 and terminated during May, 1955 and 1956. Each experiment included the same 33 treatment combinations.



View of Leafy Spurge Research Farm.

Three experiments involving the use of perennial forage crops, cultivation and 2,4-D also were initiated in August, 1950, 1951 and 1952, and were completed during May, 1954, 1955 and 1956. Each experiment included the same 44 treatments.

The results showed that complete elimination was difficult to achieve. However, stands could be materially reduced by the proper combination of competitive crops, cultivation and 2,4-D. The weed could be eliminated with 2 years of intensive cultivation, and stands could be slowly reduced in brome grass sprayed with 2,4-D, especially if fall seeding of the grass was preceded by a season of intensive cultivation. Sudangrass and buckwheat competed favorably with leafy spurge, but alfalfa did not. Small grain sprayed with 2,4-D had little effect on the stand of the weed unless post harvest cultivations were performed.

Other Chemicals

Numerous other chemicals were tested on duplicate 1- x 3- or 5-rod plots for their effect on leafy spurge. Three of them showed promise of being useful for controlling the weed.

In 4 experiments conducted during 1955-58, 2,3,6-trichlorobenzoic acid (2,3,6-TBA) was applied during mid-May. Approximately 10 days later, the weed was plowed, corn was planted and cultivated three times. 2,4-D ester was applied to some plots near the time of the second cultivation. 3-amino-1, 2, 4-triazole (amitrole) and 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) were each applied instead of 2,3,6-TBA in one or more of the experiments.

During the second year small grain was planted and sprayed with 2,4-D. After harvest 2,3,6-TBA amitrole and silvex were applied in the stubble which was plowed 10 days later. Corn was planted, cultivated and sprayed the third year. Only the application of 2,3,6-TBA before planting corn or after harvesting small grain appeared to be useful for controlling this troublesome weed.

Silvex was applied to leafy spurge growing in brome grass in two experiments. Application of 10 pounds during early June or mid-August eliminated 99% of the weed in each experiment.

Soil Sterilants

Borascu, Atlacide and sodium chlorate had proven to be effective for eliminating patches of perennial weeds. However, large amounts were needed. Their bulk made them difficult to apply and they rendered the soil unproductive (sterile) for some time. Several new soil sterilants had been developed which were easier to use. Therefore, three experiments were conducted on duplicate 9-by 15-foot plots to determine the optimum rates needed for the elimination of small patches of leafy spurge. In each experiment, the chemicals were applied on two dates--late July and mid-September. Shortly after treatment, the plots were observed to determine which chemicals were faster acting. The following year the effects of the chemicals on the weed and the grass sod infested with the weed were noted. Each succeeding year, the plots were plowed and seeded to oats to determine the length of time that the chemicals would inhibit small grain production.



Virgil Christensen, Ass't County Agent, applied chlorate and Borascu to leafy spurge patches with fertilizer spreader.

The borax compounds (Borascu 15 lb/sq. rd., Concentrated Borascu and Polybor 8 to 10 lb), the chlorate compounds (sodium chlorate 4 to 5 lb and Atlacide 6 to 8 lb) and the borate-chlorate mixtures (Polybor-chlorate and Chlorax 8 to 10 lb) eliminated 95 to 100% of the leafy spurge, but had residual effect on the oats crop for 3 to 4 years.

The borate-chlorate-monuron mixtures (Chlorax 6 to 8 lb/sq rd and Ureabor 8 lb) also gave 95% elimination with a residual period of 2 to 3 years. Erbon (Baron 1/2 to 1 lb active ingredient) was equally effective and the residue damaged oats for 2 years.

The borax-2,4-D mixture (DB Granular 5 to 7 lb/sq rd and DB Spray 5 lb) and ammonium sulfamate (Ammate 5 lb) had only 1 year of residual effect and killed over 95% of the spurge.

The substituted urea compounds (monuron, diuron & fenuron) were not effective when only 1/2 lb/sq. rd. of active ingredient was applied, but the residual effect lasted 5, 4 and 3 years respectively for the three compounds.

At these rates of application, brome grass, crested wheatgrass and bluegrass sods were damaged the least by borax-2,4-D mixtures, followed by borax compounds and ammonium sulfamate. All compounds containing sodium chlorate, erbon or substituted ureas killed practically all of the grasses.

Ammate gave the quickest top kill followed in order by erbon, DB Spray, DB Granular, the chlorates, the borate-chlorate mixtures, the borate-chlorate-monuron mixtures and the borax compounds. All chemicals were more effective when applied during the fall. The lower rate listed was effective when applied in September, but the higher rate was sometimes needed for July applications.

Experiments Discontinued

Farmer field days were held on July 1, 1952, September 1, 1953, September 1, 1954 and July 1955. A 15-minute film showing the results was made in 1955. It was shown on television and shown at county weed meetings. The lease was renewed for another 5 years and a new set of experiments developed.

RUSSIAN KNAPWEED RESEARCH FARM 1952-1957

On August 15, 1952, 12 acres infested with Russian Knapweed on the SE 1/4 of SE 1/4 of Sec 25, T 120W, R 62W were leased from Ralph Hitchcock of Stratford and his sister Mildred Hageman of Aberdeen. The field was 6 miles northwest of Conde, S.D. The only rent paid was salvage from crops not needed for experimental purposes. The same equipment used to operate the Leafy Spurge Research Farm was used on this farm.

Four general types of experiments were conducted: (1) a 3-year trial involving annual crops, cultivation, and 2,4-D on 1- by 3-rod plots; (2) a 4-year trial involving perennial

forage crops, cultivation, and 2,4-D on 1- by 3-rod plots; (3) comparisons of soil sterilants applied at several dates and rates of application on 9- x 15-foot plots; and (4) 1-year tests in which new chemicals were screened for possible use in eliminating the weed.

Annual Crops, Cultivation and 2,4-D

A 3-year experiment involved the use of annual crops (winter rye, oats and sudangrass), intensive cultivation and 2,4-D in four replications. Weed counts on the 24 treatment combinations were made as for leafy spurge. Final counts were made in May 1957.

Three treatments included a season (late May to late September) of intensive cultivation--ten cultivations at 1-week intervals, nine operations at 2-week intervals and seven cultivations at 3-week intervals. All other treatments included two winter rye crops with various combinations of 2,4-D spraying and post harvest cultivation. The third year included sprayed crop of oats, or cultivation and sudangrass.

Intensive cultivation eliminated over 90% of the knapweed in 1 year and 99% in 2 years, regardless of whether the operations were performed at 1-, 2- or 3-week intervals.

Two combinations involving the use of small grain reduced the stand more than 90% in 3 years, but the remaining 10% were difficult to kill. In one combination, a season of intensive cultivation preceded the planting of winter rye. The next year 2,4-D ester was applied during late May in the growing rye crop and again during mid-August in the stubble, resulting in 90% stand reduction. Each of the next 2 years 2,4-D was applied around the first of June in an oats crop and the oats stubble was cultivated three times. Weed density was reduced another 2% the second year and 4% the third.

The combination of crop, cultivation and chemical that most consistently reduced the stand beyond 90% included spraying with 2,4-D ester in small grain stubble, a late fall plowing, three spring cultivations and a summer-seeded crop of sudangrass.

Perennial Crops, Cultivation, and 2,4-D

A 4-year experiment initiated in August 1952 included 48 treatments involving perennial forage crops (alfalfa, brome grass and crested wheatgrass), cultivation, and 2,4-D.

All plots were plowed the third week of August. In 44 treatments, brome grass or crested wheatgrass was seeded in the fall.

Starting the next year they were sprayed with 2,4-D ester in May or August of the first year, the second year, the first and second years or the first and third years. The other six treatments included intensive cultivation from May to August in 1953 followed with a fall seeding of alfalfa and/or grass.

These crops did not compete favorably with Russian knapweed unless the weed was weakened by a season of intensive cultivation.

Five cultivations prior to fall seeding of brome grass or crested wheatgrass one year and a fall application of 2,4-D the second year reduced the weed stand 90 to 96%. Subsequent applications of 2,4-D failed to reduce the stand further. Other treatment combinations were less effective in reducing the Russian knapweed stand, but two applications of 2,4-D each year gradually decreased the stand.

Grasses sprayed with 2,4-D were more effective than alfalfa, which could not be sprayed. The knapweed emerged early and produced early rank growth. Alfalfa did not grow tall enough to overshadow it. Five cultivations prior to a fall seeding of alfalfa or alfalfa-grass mixture did not weaken the weed sufficiently to allow the crop to gain the upper hand the following spring.

Soil Sterilants

Two experiments were conducted to determine the optimum rate of application of numerous soil sterilants for the elimination of small patches of Russian knapweed. They were conducted in the same manner as for leafy spurge. The results were essentially the same as for leafy spurge except that slightly higher rates of borax compounds were needed to give 95% elimination.

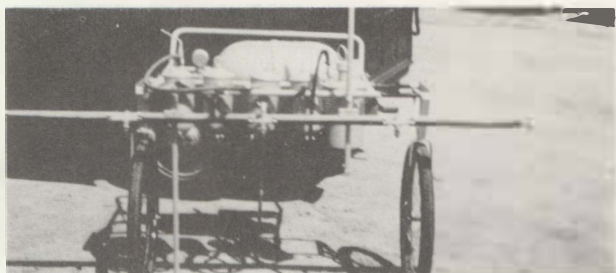
Nonselective Chemicals

Amitrole, silvex and 2,3,6-TBA were applied to the weed about May 20 in two experiments. Approximately 10 days later, the knapweed was plowed, corn was planted and cultivated three times. Almost complete elimination of the weed was achieved with 2,3,6-TBA. In one test the corn emerged normally, but died within 2 weeks. In the other test, corn was not damaged. Amitrole did not eliminate the weed and Silvex damaged the corn at rates that killed the weed.

RESEARCH EQUIPMENT AND TECHNIQUES 1951-1959

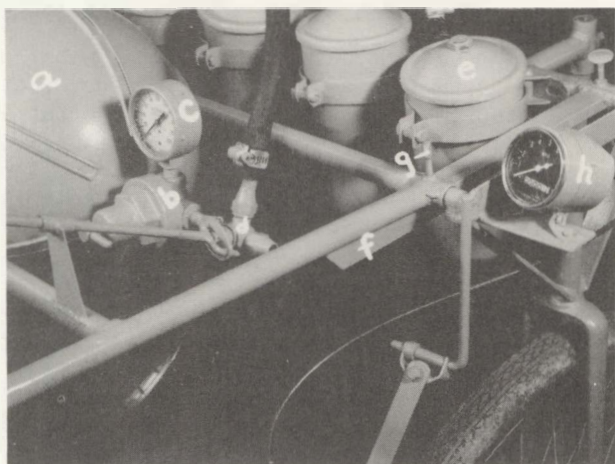
Two small plot sprayers were built in 1951--one on a wheel barrow frame and the other mounted on bicycle wheels. The wheel barrow sprayer, used for applying soil sterilants,

consisted of an auxilliary motor, a high volume centrifugal pump and a 6-nozzle 9-foot boom. The pump and boom were connected with a garden hose, and two pieces of hose connected the pump to a 5-gallon pail. The amount of chemical for a 1/2-square-rod plot and 2 to 4 gallons of water were put in the pail. Bypass from the pump put the chemical in suspension. Spray was evenly distributed on a 9- by 15-foot plot by moving the sprayer back and forth across the plot until the pail was empty. The sprayer was used on the weed farms and some county research plots.



Bicycle sprayer built in 1951.

The bicycle sprayer consisted of an Army Air Corp oxygen tank, four 2-quart containers, a 5-nozzle 8-foot boom and speedometer connected with a frame to two bicycle wheels. An aircompressor was used to fill the oxygen tank with air which was used to dispense spray from one 2-quart container at a time to the boom. One person mixed spray solutions in extra 2-quart containers, while two men (one to locate the proper plot and one to push the sprayer) sprayed four sets of plots. This sprayer replaced the knapsack sprayer for small county research plots and many experiments conducted on the weed farm at Brookings.



Close-up of bicycle sprayer.

When the Leafy Spurge Research Farm was established, plot size was reduced from that used for field bindweed. By using 1- by 5-rod plots and 33-foot roadways, almost 25 plots could be put on 1 acre. The fallowed roadways

on the Field Bindweed Research Farm were muddy when it rained and dusty in hot dry weather, so the roadways on the leafy spurge, Russian knapweed and thistle farms were seeded to smooth brome grass.

A 10-foot hay rake was purchased in 1951 for \$132 to aid in harvesting hay from the roadways and the perennial forage research plots. The Ford pickup and \$850 were paid for a 1951 1/2-ton Chevrolet pickup. The USDA equipment was transferred to the weed project when L. M. Stahler was transferred to the University of Missouri.

In 1952 the badly worn John Deere tractor and row-crop cultivator were traded for Massey Harris equipment--a 10 hp Pony tractor for \$675, 5-foot mower for \$165 and a 5-foot disk for \$77. A year later a 1-row cultivator was obtained for \$85. The tractor and mower were very useful. The side-mounted mower was better adapted to plot work than the rear-mounted John Deere mower. The tractor was also used to pull the trailer sprayer, hay rake, grain drill and 2-section harrow. The John Deere mower was sold for \$25.



Tractor and sprayer used on weed farms.

When the Russian Knapweed Research Farm was established, the Spink County Weed Board and the Soil Conservation District promised to provide a tractor and tillage equipment for use on the farm. However, while preparing the farm for the first experiments, it became apparent that such an arrangement would not be satisfactory.

Plot size was reduced to 1-by 3-rod and width of roadway reduced to 25 feet (35 plots per acre) in order to get all the treatments on the 12-acre farm. Equipment that was better adapted to plot work was needed. Also transportation equipment was needed in order to move machinery the 105 miles between the leafy spurge and Russian knapweed research locations.

Since a Ford tractor with equipment mounted on the 3-point Ferguson hitch had been satisfactory on the Agronomy Farm, a 25-hp Ford tractor and 7-foot field cultivator equipped with nine 12-inch duckfoot shovels were purchased for \$1,840 in April, 1953. A 2-bottom Ford moldboard plow was bought for \$180 and an 8-foot Ferguson tandem disk was obtained for the 12-foot John Deere disk and \$285.



Butch Griep using Ford Tractor and duckfoot cultivator in late 1950s.

Rusting was a problem with the iron spray tanks on the trailer sprayer. In 1954 two of the 22-gallon tanks were replaced with aluminum tanks and three 7 1/2-gallon aluminum tanks were added for \$150. The remaining iron tanks were used to transport a water supply and the five aluminum tanks for mixing as many spray solutions.

Also in 1954, a trailer was built to transport the equipment. Two trailer axles and wheels were obtained for \$285. Rudy Lunden, in the SDSC welding shop, and Derscheid designed and built a tandem-wheeled 8- by 18-foot flatbed trailer. When hitched to the pickup truck it could haul the little tractor and sprayer or the Ford tractor, duckfoot cultivator and disk. It served as the prototype for the trailers that were built for the Mobile Research Farms.

A 1955 3/4-ton Model F250 Ford pickup was obtained in exchange for the 1/2-ton Chevrolet and \$1,160. The larger vehicle was better adapted for hauling the flatbed trailer loaded with machinery. Also, a utility box was built for the pickup at a cost of \$80. Six compartments over the fenders on either outside of the pickup box were used to carry stakes, tools, chemicals and four 5-gallon cans of water. The Pony tractor was loaded in the pickup box and trailer sprayer towed behind, making a very mobile spraying outfit.

After the Thistle Research Farm was established in 1955, work was being done at three outlying locations and at Brookings. In order to do work at more than one location at a time, a 1955 V-8 Chevrolet stationwagon was purchased for \$2,120.

Corn was a major crop on the Thistle Research Farm. In 1955 a 2-row, rear-mounted cultivator with fertilizer attachment for sidedressing nitrogen was purchased for use with the Ford tractor for \$210.

In 1957 a 7-foot John Deere press drill with grass seeding and fertilizer attachments, was purchased for \$664. It was used for planting all spring-seeded small grain and for seeding and top dressing perennial forage crops.

Another tandem-wheeled trailer was built in 1958 at a cost of \$635. With an 8- by 10-foot flatbed, it was large enough to haul the small tractor and other light-weight equipment, but small enough to be towed behind the stationwagon.

With two trailer loads of equipment, Derscheid and a graduate student (Gail Wicks in 1958 and Walter Splittoesser in 1959) could do the spring's work on all three research farms in a 6-day week. The graduate student used the Ford tractor, disk and 2-section harrow to prepare the seedbed for spring planted crops. Derscheid used the Pony tractor to fertilize forage crop plots and seed small grains.



Heading out to do spring work in 1958.

THISTLE RESEARCH FARM 1955-1960

Twenty-five acres of land infested with Canada thistle and perennial sowthistle were leased during 1955 to study methods of eliminating these weeds. It was located 1 1/2 miles west of Castlewood in Hamlin County on SE 1/4 of SW 1/4 of Sec 27, T 115N, R 52W. The lease was signed with Leo L. Preston of Castlewood on April 12, 1955 for cash rent of \$5.00 per acre per annum, payable June 1 each year, and any salvage from crops not needed for experimental uses. The same equipment that was used on the Leafy Spurge Farm and the Russian Knapweed Farm was used on this farm.

Five general types of experiments were conducted in duplicate: (1) 1-year experiments comparing implements at several time intervals of cultivation for intensive cultivation; (2) 3-year trials involving annual crops, cultivation and 2,4-D or MCPA; (3) 3-year trials involving perennial forage crops, cultivation and 2,4-D or MCPA; (4) comparisons of soil sterilants applied at several rates on two dates; and (5) 1-year tests in which new chemicals were screened for possible use in controlling or eliminating these weeds. All plots were 1 by 5 rods in size except that soil sterilants were applied on 9- by 15-foot plots.

A 14- by 20-foot building, that had been used as an office by the contractor while building Hillcrest School in Brookings, was purchased in 1955 for \$350. An 8-foot door was cut in one end, and the building moved to the farm to house tractors, small implements and supplies.



Building and equipment on Thistle Research Farm.

The area used for 3-year experiments in 1955 was heavily infested with Canada thistle and moderately infested with perennial sow-thistle. The number of plants of each species was counted annually during the first week of June in 1955 to 1958 in the same manner as for leafy spurge and Russian knapweed.

An identical set of 3-year experiments was initiated in 1956 on an area that contained few sowthistle plants. Counts of Canada thistle plants were made annually from 1956 to 1959.

Intensive Cultivation

A 1-year experiment was conducted during 1955. Three treatments included the use of the duckfoot field cultivator at a depth of 4 inches at 2-week (8 operations), 3-week (6 operations), and 4-week (5 operations) intervals. Three other treatments included the use of a one-way disk operated at the same depth and time intervals. The seventh treatment included double disking with the 8-foot tandem disk operated at a depth of 3 to 4 inches every 2 weeks (16 operations). An identical experiment was conducted during 1956.

All treatments killed over 99% of both species of thistles, indicating that the duckfoot cultivator or one-way disk need not be used any oftener than every 3 or 4 weeks and that the tandem disk harrow could be substituted for them if used twice (double coverage) every 2 weeks.

Annual Crops, Cultivation and Chemicals

Identical 3-year experiments initiated in 1955 and 1956 included 48 treatment combinations of intensive cultivation and/or spraying with 2,4-D or MCPA on crop rotations common to the area. The crop rotations included (1) continuous oats, (2) oats-corn-oats, (3) oats-corn-oats, (4) oats-sudan and cult-flax, and (5) oats-corn-flax. The two experiments were completed in 1958 and 1959, respectively.

Spraying with MCPA or 2,4-D prevented seed production, killed susceptible plants and weakened resistant plants so that later treatments could deliver the knockout punch. The knockout punch was delivered by spraying and/or cultivating after harvest of small grains or the production of strongly competitive crop of sudangrass the next year.

The most effective control method was to spray in small grain during early June and duckfoot the stubble three times at 3-week intervals after harvest. About 90% of the weeds were eliminated in 1 year and 98% in 2 years.

Though corn sprayed in early June and again after tasseling was less effective than a second crop of small grain, it prevented re-infestation and reduced the stand somewhat. The most practical rotation was perhaps small grain-corn-small grain in which the spraying and cultivating were done.

Perennial Crops, Cultivation and Chemicals

Identical 3-year experiments, in which various combinations of alfalfa or bromegrass, intensive cultivation and 2,4-D or MCPA were compared, were initiated during the springs of 1955 and 1956 and completed in June 1958 and 1959, respectively.

A season of intensive cultivation followed by a late-summer seeded crop of alfalfa and/or bromegrass eliminated 95 to 100% of the thistles in 2 years. Without the intensive cultivation, 3 years were required to give similar results. When good grass stands were maintained, the application of 2,4-D or MCPA did not improve results materially.

Soil Sterilants

One experiment was conducted to determine the optimum rate of application of numerous soil sterilants for the elimination of small patches of thistles. The experiments were similar to those used for leafy spurge and Russian knapweed and the results were similar. However, leafy spurge was killed with lower rates of the borax compounds than was required for Russian knapweed, Canada thistle or perennial sowthistle.

Nonselective Herbicides

In several experiments several herbicides were screened for possible use in controlling thistles. Those tested in 1955 included amitrole, 2-chloro-4,6 bis (diethylamino)s-triazine (chlorazine), 2,4-dichloropropionic acid (2,4-DP), 2-methyl-4-chlorophenoxy-propionic acid (MCPA), 4-(2,4-dichlorophenoxy) butyric acid [4-(2,4-DB)], and polychlorobenzoic acid compounds--2,3,6-TBA and PBA.

Several of the herbicides appeared promising, but only amitrole and 4(2,4-DB) were tested extensively. During 1956 and 1957, amitrole was applied at two stages of growth--spring rosette and bud, while 4-(2,4-DB) was applied to the spring rosette stage of growth.

Amitrole at a rate of 4 pounds per acre killed 90 to 95% of the Canada thistle plants when applied at the bud stage of growth. The 4-(2,4-DB), on the other hand, appeared to be useful in checking growth and preventing seed production. It was useful for aiding in the establishment of legumes in Canada thistle infested areas.

Station Closed

Field days were held in August 1956 and July 16, 1958. A 15-minute film, showing the results, was made in 1956. It was shown on television several times and used at numerous county educational meetings. The farm was discontinued in June 1959 after weed counts were made. The building was moved to the Agronomy Farm at Brookings.

ACHENE DEVELOPMENT OF THISTLES 1955-1958

Fourteen experiments were conducted to study achene (seed) development of Canada thistle and perennial sowthistle. Two compared bees and wind currents as pollinating agents for Canada thistle and one made the same comparisons for perennial sowthistle. Two were used to determine whether sowthistle was self- or cross-pollinated; three studied the age of heads of sowthistle when seeds became viable and two gave similar information on Canada thistle; two were conducted on sowthistle and two on Canada thistle to determine the latest stage of growth when mowing would prevent the production of viable seed.

Pollinating Agents

Cuttings of Canada thistle were exhumed by Russel L. Nash and transplanted into a 4- by 20-foot greenhouse bench during the summer of 1955. Cuttings from staminate (male) and pistillate (female) plants were planted at a ratio of one to five. Similarly, cuttings of perennial sowthistle were transplanted into another bench.

When Canada thistle plants started flowering during the winter of 1955-1956, honey bees were released in the greenhouse and 175 female heads were tagged. The bees were removed, and the heads allowed to mature. They produced an average of 43.5 mature seeds per head. One hundred new heads were tagged, and an 18-inch fan was used to blow air across them for 9 hours a day for 2 weeks. They produced an average of only 0.76 mature seeds per head. The bees were returned to the greenhouse and the plants produced seed again.

During the winter of 1956-1957 Robert Schultz repeated this experiment with both Canada thistle and perennial sowthistle. The

results for both species were similar to the 1955-56 results for Canada thistle.

Honey bees aided in the pollination of Canada thistle and perennial sowthistle. In the greenhouse they were much more effective than air currents.

Source of Pollen

Since sowthistle seed production was stimulated by the use of bees as a pollinating agent, it appeared that this species might be cross-pollinated even though female and male organs were in each flower.

During the winter of 1956-1957 Schultz pollinated 100 heads of perennial sowthistle with their own pollen--91 failed to produce fruit. The other 9 produced 1548 seeds, but only one germinated.

At the same time 100 heads were close-pollinated with pollen from other heads on the same plant--95 failed to produce seed. The other 5 produced a total of 637 fruits and all failed to germinate.

Ten heads, which were cross-pollinated with heads on different plants, produced an average of 47.9 mature fruits per head, of which 80% were viable.

The following summer Schultz conducted a similar experiment in the field. 100 heads were self-pollinated, 24 closed-pollinated and 100 were cross-pollinated. Of the selfed heads, 91 failed to produce fruit, 4 produced an average of 2 seeds and 5 produced an average of 127 per head. However, none of the 637 seeds would germinate.

Sixteen of the close-pollinated heads produced 1.5 seeds per head and the other 8 heads developed 87 seeds. Only 6 of the 91 seeds germinated. Of the cross-pollinated heads 81 produced an average of 45.9 achenes of which 68% were viable. Five heads produced an average of less than 5 seeds and 14 did not develop seeds.

Perennial sowthistle was largely cross-pollinated. Very few viable seeds developed when flowers were pollinated with pollen from the same head or from flowers on other heads growing on the same plant.

Age of Flowers When Seeds Became Viable

In a preliminary experiment by Darrold Ter-munde, all flowers on a patch of perennial sowthistle were removed on July 17, 1955. The next day, tags were placed on heads that opened during the intervening 24-hour period. Twenty heads were harvested on each of the fourth

through the ninth days after they opened. Heads were air dried and threshed and seeds tested for viability.

Schultz conducted similar experiments in 1956 and 1957. In one experiment, the flowers were removed from all plants in a patch on July 16, 1956. Over 1100 heads were tagged before they had been open 24 hours. Seventy-five heads were harvested on each of the third through eleventh days after they opened. They were air dried and 20 heads for each date were threshed separately. The number of achenes was counted, and those from each head were germinated separately.

A third experiment was conducted in the same manner during 1957. Twenty heads for each date were germinated in 1957, and 10 were handled in the same way after being stored for 1 year.

Two Canada thistle experiments conducted during 1956 and 1957 were very similar to the perennial sowthistle experiments during the same years.

A high percentage of sowthistle achenes were viable about 1 week after the heads opened; 2 more days were required for Canada thistle. The exact number of days varied slightly from year to year.

Mowing to Prevent Seed Production

During 1956, Schultz tagged heads of Canada thistle and perennial sowthistle the day they opened. Some plants were mowed daily on the fourth through eleventh days later and allowed to dry in the field for 3 days before being threshed. Seeds from 5 to 15 heads were tested for germination. Similar experiments were conducted in 1957.

Although it was known that seeds were not viable on heads that had been open less than 6 days when they were removed from the plant, it was felt that those on mowed plants might develop from food stored in the plant.

In two experiments with each weed, the percentage of viable seeds from heads of plants mowed at various stages of growth was very similar to the percentage of viable seeds from heads that were removed from plants at the same age, indicating that mowing must be done before heads had been open 8 or 9 days for sowthistle and 10 or 11 days for Canada thistle in order to prevent the production of viable seed. The exact number of days varied slightly from year to year.

ENVIRONMENTAL FACTORS AFFECTING GERMINATION AND SEEDLING DEVELOPMENT OF CANADA THISTLE

Seeds of Canada thistle were collected by Sam Zilke from numerous patches within a

20-mile radius of Brookings during the years 1956 to 1959. Some were collected from the same patch each year. The material was dried, threshed and stored at room temperatures, and subjected to different environmental treatments in the field, greenhouse and laboratory.

Field Tests

In the field, untreated and pretreated seed was planted at approximately 2-week intervals, at four sites; Russian Knapweed Research Farm, Thistle Research Farm, Leafy Spurge Research Farm and Agronomy Weed Farm at Brookings. Soil temperature was measured from depths of 0, 1/2, 1, 2, 3, 4 and 6 inches, accurate rainfall records were kept and soil moisture samples were taken periodically.

Soil temperature regimes in Eastern South Dakota at a 1/2-inch depth were favorable to germination in May, June and September. Temperatures were too low in April and too high in July and August. Germination occurred when soil moisture exceeded the wilting point if temperatures were favorable. About 10% germination could be expected if rainfall was as low as 50% of normal. Average germination in the field was generally less than one-third of that in the laboratory or greenhouse.

The extent of hypocotyl elongation allowed emergence only from shallow depths. Emergence from depth was variable but maximum depth was 3 to 5 millimeters. The seed was thermoperiodic and germination could only be induced when at shallow depths and when range of diurnal temperature oscillations were wide.

Laboratory Tests

Germination of 2-year-old seed was higher and more uniform than that of fresher seed under several treatments. Remoistening of dried seed on paper in the laboratory induced 65% germination, however, remoistening of seed in secondary dormancy in soil only induced 35% germination.

Seed absorbed moisture at constant temperatures from 1 to 30°C and absorption was complete in 12 to 48 hours. Seed was highly permeable to water from the time it matured until several years of age under most temperature conditions.

The seed could get sufficient oxygen for germination at oxygen concentrations as low as 3% if carbon dioxide concentration was at least 1% but less than 4 times the oxygen concentration.

LEAFY SPURGE RESEARCH FARM
1957-1961

From 1950 to 1956, it was learned that several combinations of crops, cultivation and chemicals would reduce the stand of leafy spurge. In the meantime, research on Canada thistle and perennial sowthistle showed that those weeds could be eliminated while using crop rotations common to the area.

Though the effective systems developed for leafy spurge utilized crops adapted to South Dakota, they were not used in profitable crop rotations. Consequently, a second series of studies was initiated in which crop rotations adapted to Northeastern South Dakota were used.

The 30-acre Research Farm used for the previous studies was used for these experiments. The previously delineated plots were used and weed control was determined in the same manner as with the earlier experiments. Three types of experiments were conducted: (1) 4-year trials in which information gained in the previous studies was used to develop good cropping sequences for eliminating leafy spurge, (2) 2- or 3-year trials in which non-selective herbicides were applied before planting corn and after harvesting small grain to develop methods of eliminating the weed, and (3) 4-year experiments designed to learn how common crop rotations should be managed to prevent reinfestation of land on which the weed had been eliminated.

Crops, Cultivation and
2,4-D for Elimination

Identical 4-year experiments were initiated during 1956 and 1957. They were completed in 1959 and 1960, respectively. Rotations used were: (1) cultivation-alfalfa-alfalfa-corn, (2) cultivation-alfalfa-wheat-corn, (3) cultivation-bromegrass-bromegrass-corn, (4) cultivation-bromegrass-wheat-corn, (5) oats-bromegrass-bromegrass-corn, (6) oats-bromegrass-wheat-corn, (7) oats-oats-sweetclover-corn, (8) oats-oats-sweetclover and fallow-corn, (9) sudangrass-oats-sweetclover and fallow-corn, (10) sudangrass-oats-wheat-corn, and (11) sudangrass-rye-wheat-corn. They were modified with the addition of 2,4-D and special cultivation to form 32 treatments in each experiment.

Exactly half of the treatments eliminated 90% or more of the leafy spurge in 4 years. Nine of the treatments utilized a season of intensive cultivation before seeding a perennial crop the first year and six treatments included cultivation and a crop of sudangrass the first year. The other treatment included cultivation and sudangrass the second year.

Only two of the five treatments utilizing cultivation and alfalfa the first year eliminated over 90% of the spurge in 4 years. Third year operations were important. Alfalfa or wheat without post harvest operations were inferior to wheat that was sprayed in the grain and cultivated after harvest.

Treatments that included cultivation and bromegrass the first year eliminated over 90% of the leafy spurge. During the second and third years two 2,4-D applications a year eliminated more weeds.

One year of cultivation and sudangrass was so effective that spraying in small grain reduced stands still further the next year and similar operations maintained the percentage kill in subsequent years.

Crops, Cultivation, 2,4-D and
Nonselective Herbicides

In two experiments corn was planted the first year and oats the second. The crop sequence was reversed in two other trials.

In each test 2,4-D was applied to the crop. 2,3,6-TBA and amitrole were used in all four experiments, and PBA was tested twice while simazine and silvex were each tested once.

In the oats-corn rotation, the oats were sprayed with 2,4-D in early June. In mid-August other herbicides were applied to the stubble. Plowing was performed 10 days later for PBA and 2,3,6-TBA and 15 days for amitrole. PBA was unsatisfactory in the first test and omitted from the second. However, 2,3,6-TBA and amitrole reduced leafy spurge stands materially.

During the second year, 2,3,6-TBA and amitrole were applied in mid-May when leafy spurge was 6 to 10 inches tall. Ten days later all plots were duckfoot cultivated. Corn was planted immediately, cultivated three times during the season and sprayed with 2,4-D one week after the first cultivation. The stand of leafy spurge became more dense on all plots in both experiments.

In the corn-oats rotation, simazine, PBA, 2,3,6-TBA and amitrole were applied in mid-May. Ten days later the plots were plowed. Corn was planted, cultivated and sprayed with 2,4-D. PBA and simazine were ineffective. Silvex equalled 2,3,6-TBA and amitrole for weed control, but killed the corn.

During the second year, oats were handled the same as in the oats-corn rotations. The stand of leafy spurge was not materially decreased in either trial. No crop damage was noted either year.

Crops, Cultivation and Herbicides to Prevent Reinfestation

Two 4-year experiments were initiated in 1956 and 1957 and terminated in May 1960 and 1961. Each was conducted on areas where leafy spurge had been weakened by previous experiments and eliminated by a season of intensive cultivation. No leafy spurge plants were found on any of the plots when the trials were initiated.

Five basic rotations, (1) oats-oats-wheat-corn, (2) oats-corn-wheat-corn, (3) oats-alfalfa-wheat-corn, (4) oats-sweetclover-wheat-corn, (5) oats-sweetclover and fallow-wheat-corn were each modified by the use of 2,4-D or 4-(2,4-DB) and special cultivation to form 20 treatments.

Of the seven treatments that allowed reinfestation of more than 1 plant per square yard, four did not include a 2,4-D application during any of the 4 years. Plots that received 2,4-D each of the 4 years contained 0.4 plants per square yard with a range of 0 to 1.9 plants. The same was true for plots receiving the 15 treatments that utilized 2,4-D the fourth year and included sprayed small grain, sprayed corn or a forage crop during the previous year.

The farm was discontinued after weed counts were made in May 1962. The garage was moved to the Agronomy Farm.

VEGETATIVE BUD ACTIVITY AND SEED DEVELOPMENT OF LEAFY SPURGE

In 1956 to 1958 Gail A. Wicks conducted studies of vegetative bud development and seed development of leafy spurge. Studies were conducted on: (1) the development of seeds, (2) the effects of environment on root bud dormancy, and (3) the effects of auxin and anti-auxin on vegetative buds.

Seed Maturation

The relationship between leafy spurge seed color, viability and maturity was investigated in two separate experiments conducted near Brookings in 1957. The day the female flower was inverted between the bracts enclosing the cyathium was determined. Pollination usually occurred within 24 hours. Ovaries and capsules began to enlarge in 7 or 8 days and appeared fully developed in another 2 days. The first seeds were shriveled and yellow.

As the seed increased in age, the color changed from yellow to yellow with brown tips. The brown tips enlarged from both ends until the yellow area was a narrow band. These were called yellow stripe. The stripes changed to

orange giving the seeds an orange-brown appearance. As the orange became darker, the seeds appeared reddish brown and then brown.

Next a gray line developed along one side. It gradually enlarged until the seeds were gray-brown and then gray. Tiny brown spots appeared and gradually increased until the seeds were distinctly mottled. Some seeds were much more darkly mottled than others. Some white seeds occurred during the latter part of maturity and were classed with the yellow seeds. The rapidness of color change depended on environmental factors, such as rainfall, humidity and temperature. Optimum rainfall, high humidity or low temperature tended to delay development.

Yellow, yellow stripe, orange-brown and reddish-brown seeds were nonviable, but brown, gray-brown, gray and mottled seeds were capable of germinating.

Mowing before seeds turned brown (10 to 13 days after capsules inverted) prevented production of viable seeds. The exact number of days varied with growing conditions.

An application of 1/2 pound of 2,4-D ester did not prevent the production of viable seed if spraying was delayed more than 5 days after the capsules inverted.

Vegetative Bud Activity and Development

In one experiment leafy spurge roots were exhumed at weekly intervals in the fall of 1957 and transplanted in greenhouse pots to study the natural environment of root bud activity. In two experiments transplants were exposed to different photoperiods to learn the effect of day length on root bud development. In a fourth experiment auxin and anti-auxin were applied in various concentrations to the cut surfaces of decapitated leafy spurge shoots to determine effects of these hormones on development of axillary buds on above-ground and below-ground plant parts.

Natural dormancy existed in leafy spurge--leaves were thicker and internodes shorter than normal and root buds failed to elongate. Dormancy was brought about by short days and cool temperatures. It appeared that a killing frost was instrumental in causing complete dormancy.

Low temperatures caused natural after-ripening, hence the breaking of dormancy.

Root buds developed and grew under conditions of short days. Temperature regulated the rate of growth. Cool temperatures produced a "hardening-off" effect and was very instrumental in flower initiation. Root buds

subjected to cool temperatures produced shoots that flowered much quicker than root buds under warm temperature conditions.

The effects of auxin and anti-auxin on the root bud development were indefinite. In general, trans-cinnamic acid promoted growth of axillary buds and inhibited development of the root buds. Indole-3-acetic acid suppressed growth of root buds and for a short time suppressed axillary buds.

ANATOMY AND BUD FORMATION OF SUBTERRANEAN PARTS OF LEAFY SPURGE

Charles A. Beasley conducted several experiments to: (1) determine the best method of germinating the seed of leafy spurge, (2) determine the effect of auxin and anti-auxin on seedling development, and (3) study some factors affecting vegetative bud formation and the anatomy of subterranean parts of leafy spurge.

Germination

Leafy spurge seeds were sorted into three color classes: mottled, gray and purple. Seeds were subjected to various conditions of light and temperature and to water extracts from leafy spurge seeds of various stages of maturity.

Rate of germination and germination percentage were highest for mottled seeds followed, in order, by gray and purple seeds. Light decreased both the rapidity and percent germination. Mottled seeds approached maximum germination with two cycles of 12 hours at 86°F and 12 hours at 68°F. Less mature seeds (gray and purple) required more cycles. However, the 24-hour cycles could be replaced by 14 days of constant 86° followed by constant 68°. Seed extracts also inhibited germination. Inhibition was greater from extracts of immature seeds than from those that were fully developed.

Seedling Development

Uniformly germinated mottled seeds were subjected to various growth substances and seed extracts. Root segments from plants grown in sucrose and sucrose-adenine media were subjected to treatments with kinetin and IAA. Hypocotyl segments were subjected to various rates of kinetin and IAA, alone and in combinations.

Vegetative parts failed to develop normally unless the root tip was left intact. Glucose reduced hypocotyl and epicotyl extension after the root was removed from the seedling much more than sucrose did. Maximum growth of isolated root tips was obtained when the roots

were subjected to the same alternating temperature conditions as the parent seeds and seedlings from which they were removed. Epicotyl growth was delayed when cotyledons were removed.

Adenine sulfate, auxins and anti-auxins did not affect seed germination, but did retard growth of the seedlings. Adenine sulfate further decreased root growth when added with the already inhibitory kinetin. Adenine sulfate increased growth of isolated root tips when grown in a sucrose-based media; however, growth was variable. Root segments from a plant grown on sucrose-based media was induced to maximum lateral root initiation by addition of IAA. On root segments from a plant grown on sucrose-based media supplemented with adenine sulfate.

Kinetin had very little, if any, effect upon germination but seriously inhibited growth of seedlings. Synergistic inhibition was caused when indole acetic acid IAA and kinetin were added together. Bud formation on hypocotyl segments was stimulated by kinetin, but this effect was removed by addition of IAA. Likewise, stimulation of bud initiation from kinetin was non-existent if the plant from which the segments were taken had been grown on adenine sulfate-supplemented media.

Anatomy

Anatomical studies were conducted on isolated root segments and seedling plants in culture and on seedlings and mature plants grown in the greenhouse and in the field.

The main axis of a mature plant of leafy spurge was composed of above-ground stem(s), a hypocotyl region varying from a few millimeters to a few centimeters in length, a transition zone, and the primary root. The vertical, primary root produced lateral roots, feeder roots and adventitious buds. Lateral roots in turn produced additional lateral roots, feeder roots and adventitious buds. Adventitious buds could develop into vertical, underground and above-ground shoots. In established patches of leafy spurge, about 90% of the above-ground shoots arose from adventitious buds on lateral roots. Crowns of buds, at and just below the soil surface, were formed both from vertical stems and from the collet or hypocotyl region of the main axis (stem).

The transition zone between the stem and root of leafy spurge was found in the collet (lower hypocotylary swelling). The transition from exarch radial stele of the root to endarch collateral stele of the upper collet was complete in approximately 2500 microns. All root primordia had endogenous origin from

pericycle and pericyclic tissues. Buds arose endogenously in roots but exogenously in the region of the hypocotyl with endarch protoxylem. In many cases, primordia could be identified as roots or shoots prior to their emergence from the main axis.

ROOT AND ROOT BUD DEVELOPMENT OF LEAFY SPURGE

In 1961 and 1962, Leon J. Wrage conducted a study with leafy spurge to: (1) determine chronology of root development and bud formation, (2) determine the effects of some environmental conditions on bud formation on seedling plants and (3) study the relationship between the chronology of bud formation on seedlings and ability of decapitated seedlings to reproduce top growth.

Chronology of Root Development

In one experiment bud development was studied on greenhouse-grown seedlings ranging from 1 to 40 days of age. Buds emerged on the hypocotyl of 4-day old seedlings and on the roots of seedlings from 4 to 10 days of age.

In another experiment leafy spurge was grown outside in large containers. Plants were exhumed and examined at monthly intervals from 1 to 5 months and at 15 1/2 months of age. Primary lateral roots with emerged buds developed during the third month of growth and secondary laterals formed during the fourth month. Tertiary lateral roots were formed on the 15 1/2-month old plants. A total of 5 buds were found on the root system of a plant that was one month old, with 34 at 2 months, 115 at 3 months, 338 at 4 months and 1489 at 15 1/2 months of age.

Environmental Effects

Leafy spurge seedlings were grown under 16 combinations of high and low temperatures with long and short photoperiod and on six fertility and soil moisture conditions.

More buds emerged on seedlings grown under high moisture and fertility conditions, under higher temperature (65-75° F), and under long day lengths (19 hours) at the higher temperatures. When plants were moved to subsequent environments, more buds formed under long day lengths. Bud elongation of 2 millimeters or more in length was stimulated by low temperatures (55-60 F) in the subsequent environment.

Regrowth Capabilities

Seedlings at 1 to 40 days of age were cut off 1/2 inch above the soil surface or at the root-shoot transition zone.

Seedlings 1-day old were capable of regrowth when decapitated 1/2 inch above the soil. Seedlings decapitated at the root-shoot transition zone were able to produce regrowth after they were 5 days of age.

RUSSIAN KNAPWEED RESEARCH FARM 1957-1962

The option of the old lease for the 12-acre farm used from 1952 to 1956 was claimed. A new lease signed on January 15, 1957 was for 5 years for \$5 per acre per annum, payable June 1 each year, plus any salvage from crops not needed for experimental work. New experiments were conducted on the plots delineated during 1952 to 1957.

Three types of experiments were conducted: (1) a 4-year trial in which information obtained in the previous series of studies was used to develop good cropping sequences for eliminating Russian knapweed, (2) 2- and 3-year trials in which nonselective herbicides were applied before planting corn and after harvesting small grain to develop methods of eliminating the weed, and (3) a 4-year experiment designed to learn how common crop rotations should be managed in order to prevent reinfestation of land on which the weed had been eliminated.

Crops, Cultivation and 2,4-D for Elimination

A 4-year experiment was initiated in 1958 in which 32 treatments were applied in triplicate. Treatment was terminated the fall of 1961 and final weed counts made in May 1962.

Rotations used were: (1) cultivation-alfalfa-alfalfa-corn, (2) cultivation-alfalfa-wheat-corn, (3) cultivation-bromegrass-bromegrass-corn, (4) cultivation-bromegrass-wheat-corn, (5) oats-bromegrass-bromegrass-corn, (6) oats-bromegrass-wheat-corn, (7) oats-oats-sweetclover-corn, (8) oats-oats-sweetclover and fallow-corn, (9) sudangrass-oats-sweetclover and fallow-corn, (10) sudangrass-oats-wheat-corn, and (11) sudangrass-rye-wheat-corn. They were modified with the addition of 2,4-D ester and special cultivation to form the 32 treatments.

Russian knapweed was more difficult to kill than leafy spurge. Treatments that reduced the stand of leafy spurge 90% or more in 4 years reduced the stand of Russian knapweed 37 to 72% for an average of 60% in the same length of time.

Only two treatments reduced the stand of Russian knapweed by as much as 90%. They both included smooth bromegrass sprayed with 1

pound of 2,4-D ester in early June and 1 1/2 pounds in August during the second and third years and late fall plowing the third year. Both reduced the stand by 90% in 3 years. Control pressure by cultivation, spraying and competition was exerted continuously over the 3-year period. Corn was raised the fourth year and established plants were allowed to spread.

Nonselective Herbicides

Experiments initiated in 1958 included an oats-corn-oats rotation in one test and a corn-oats rotation in the other. Whenever oats was grown, it was sprayed with 2,4-D ester in June and nonselective chemicals were applied after harvest. The treated stubble was plowed 10 to 15 days after the spraying.

When corn was grown the nonselective herbicides were applied in the spring. About 10 days later plots were plowed in the corn-oats rotation and duckfoot cultivated in the oats-corn-oats rotation. Corn was cultivated three times and sprayed with 2,4-D.

In the oats-corn-oats rotation the non-selective herbicides were 2,3,6-TBA, PBA and amitrole. Rates of 4 and 6 pounds of 2,3,6-TBA and 8 of PBA gave almost complete elimination the first year. Amitrole and lower rates of both herbicides were less effective.

During the second year, corn stands were reduced 75 to 100% by various rates of 2,3,6-TBA and PBA. Two sprayings had been performed in a 9-month period and the spring application had not been plowed. Amitrole did not cause damage.

At the end of 3 years all treatments with 2,3,6-TBA and PBA had eliminated over 90% of the knapweed. A total of 6 to 8 pounds per acre of 2,3,6-TBA reduced the stand 95 to 99%. One application of 6 pounds reduced it 90% in 1 year; 8 pounds in two applications (4 pounds each year) reduced it 99% in 2 years; and 6 pounds in three applications (2 pounds each year) reduced it 95% in 3 years.

Although the experiment was terminated in 1960, corn was planted on the area in 1961. Residues from the previous treatments seriously damaged corn planted on plots that had received 6 to 8 pounds of 2,3,6-TBA.

In the corn-oats experiment, 2,3,6-TBA, PBA, simazine and silvex were applied before planting the corn. The latter two chemicals were ineffective against knapweed and the first two were less effective than during the first year of the oats-corn-oats rotation.

During the second year of this rotation, the stand of Russian knapweed was materially

reduced by all treatments and five of them resulted in over 95% elimination in 2 years. No crop damage was noted. Oat yields were two to three times higher than in other experiments during this dry year.

Although the experiment was terminated, corn was planted on the area the next year. No damage to the crop was noted because applications of 2,3,6-TBA and PBA were spaced 15 months apart.

Crops, Cultivation and Herbicides to Prevent Reinfestation

One 4-year experiment was initiated in 1958 and terminated in 1961. The area had been intensively cultivated during the fall of one year and all season the next year to eliminate weeds not killed in the previous experiments. Complete elimination was not obtained by the intensive cultivation.

Five basic rotations (1) oats-oats-wheat-corn, (2) oats-corn-wheat-corn, (3) oats-alfalfa-wheat-corn, (4) oats-sweetclover-wheat-corn, and (5) oats-sweetclover and fallow-wheat-corn were each modified three times by the use of 2,4-D or 4-(2,4-DB) and special cultivation to form 20 treatments applied in quadruplicate.

Only two treatments prevented reinfestation for 4 years. They included a crop of oats sprayed with 1/2 pound of 2,4-D or 2 pounds of 4-(2,4-DB) the first year and a crop of sudan-grass or sweetclover the second. A crop of wheat was sprayed with 2,4-D in the grain and cultivated three times after harvest during the third year and corn was sprayed with 2,4-D during the fourth year.

The few plants remaining at the beginning of the experiment were not killed by any of the 4-year treatments. However, the one season of intensive cultivation prior to initiation of the experiment had apparently weakened the knapweed plants to the extent that about half of the treatments prevented any vegetative reinfestation for 2 years.

Established plants probably produced enough new shoots to account for the increased number of plants, and several of the treatments probably prevented reinfestation from seedlings.

Farm Discontinued

Farmer field days were held in 1958 and 1961. The farm was discontinued after weed counts were made in May 1962.

COUNTY SCREENING TRIALS 1960-1961

During the late 1940s and early 1950s county research plots had been used to test

2,4-D, MCPA, 2,4,5-T and several chlorate and borax compounds for their effects on several species of noxious weeds. During the ensuing decade numerous new herbicides had been developed. County plots were used in an attempt to learn the rate of application and time of year that they would be most effective in controlling or eliminating noxious weeds.

PBA, 2,3,6-TBA, amitrole-T, simazine, fenac, amiben and dicamba were applied to different plots on three dates: late June, mid-August and early October. In 1960 field bindweed was treated in six counties, Russian knapweed in five, leafy spurge and Canada thistle each in three, perennial sowthistle in two and hoary cress in one county.

RESEARCH EQUIPMENT AND TECHNIQUES 1960-1965

The 1955 Ford pickup was replaced with a 1959 model F250 Ford and the 1955 Chevrolet station wagon was traded for a 1960 Ford station wagon.

Also in 1960, the trailer sprayer was modified for use in screening many new herbicides in county research plots and on research farms.

By adding several features it became a logarithmic sprayer without affecting its previous use for spraying field plots. The boom was lengthened from 16 1/2 to 20 feet by adding one nozzle at each end. For the new sprayer a separate set of 12 nozzles was mounted on the same boom. A modified centrifugal pump and separate motor were mounted at the rear of the sprayer and connected to one of the water tanks.

About a quart of chemical or a highly concentrated mixture of chemical and water was poured into the new pump. When the valve to the boom was opened, the chemical was discharged. As the chemical left the pump, it was replaced with water which diluted the mixture. The concentration of the spray gradually decreased as the sprayer moved across a plot--50% in 17 feet at a speed of 3 miles per hour, and 21 feet at 2 miles per hour. The effects of a wide range of concentrations could be determined on one 20- x 80- to 100-foot plot that could be sprayed in a very few minutes.

The Massey Harris tractor and mower were badly worn. The production of the Pony model had been discontinued. Consequently, the Massey Harris tractor and equipment were traded for a Cub Farmall tractor with mounted 1-row cultivator and 5-foot rotary mower. The Cub had only 8 1/2 horsepower and was less useful on the weed research farms, but more useful for the plots at Brookings.

With establishment of the Field Bindweed Research Farm at Presho, new equipment was needed to perform farming operations commonly used in South Central South Dakota. Winter wheat and sorghum were the major crops and summer fallowing was a common practice.

The bindweed farm was only 10 miles from the South Central Mobile Research Farm. A tractor and 5-foot one-way disk, equipped with 16-inch disks, was borrowed from the mobile unit to perform fallow operations in the manner used by area farmers. A 70-foot Massey Harris combine was also borrowed to harvest small grain plots. The bindweed farm was located about 340 miles from Brookings and a man hired part-time by both farms did the routine tillage operations of fallowing and post harvest cultivations.

The 1953 Ford tractor did not have enough power to plow the heavy soils on the new farm. In 1962 and 1963 a 35-horsepower Ford tractor, a deep furrow drill and a new field cultivator were purchased. The 6-foot Dempster drill seeded 6 rows spaced 1 foot apart and was needed for the seeding of winter wheat. It also served as a sorghum seeder when four of the feed spouts were shut off so that it planted two rows with 3-foot spacings. The 7-foot field cultivator was equipped with three 30-inch sweeps for cultivating small grain stubble. When operated at a depth of 4-inches, it cut all the roots of the field bindweed and left most of the small grain residue on the surface for soil conservation.

Plot size was 20 by 50 feet with 25-foot roadways on the Field Bindweed Research Farm. A 20-foot width was well adapted for use with the 7-foot duckfoot cultivator, 7-foot blade cultivator, 7-foot press drill used for spring wheat, the 6-foot deep furrow drill used for winter wheat and sorghum, the 8-foot tandem disk, the 20-foot sprayer and the 5-foot one-way disk.

One roadway was 50 feet wide to serve as a runway for the college plane when it was sometimes used to make the 340-mile trip to the farm.

FIELD BINDWEED RESEARCH FARM 1962-1966

After devoting several years to such weeds as leafy spurge, Russian knapweed, Canada thistle and perennial sowthistle, it was believed that the same control methods would eliminate field bindweed that were effective on the thistles.

While these practices had not been tested experimentally on field bindweed, some had been used by farmers with very satisfactory results.

More than a decade after the Field Bindweed Research Farm at Scotland was discontinued another research farm was established near Presho in western Lyman County.

A 24-acre crested wheatgrass field, which was badly infested with field bindweed, was leased during 1962. The area was located 18 miles southwest of Presho, on SW 1/4 of SW 1/4 of Sec 4, T 103N, R 78W.

A 20- by 40-foot prefabricated building was constructed from half of a prefabricated army barracks that had been used as a 3-apartment complex for student housing. Almost all the machinery and supplies used at the farm were stored in it.

The number of field bindweed shoots was counted during early June before any cultivation or herbicide treatment was applied and during early June of each succeeding year to determine the effect of each year's treatment. Final counts were made the year after the final treatments were applied.

Annual Crops, Cultivation and 2,4-D

Identical 4-year experiments were initiated in the fall of 1963 and 1964 and completed the fall of 1966 and 1967, respectively.

Rotations common to South Central South Dakota were used: (1) continuous wheat, (2) wheat-fallow, (3) wheat-sorghum, and (4) wheat-sorghum-fallow. Both spring wheat and winter wheat were used in each rotation except that sorghum could not be harvested in time to plant winter wheat in the second sequence of the winter wheat-sorghum rotation.

Each rotation was modified by the use of special cultivation and 2,4-D treatment to form 40 treatments (20 with spring wheat and 20 with winter wheat) in each experiment. Crested wheatgrass sod was plowed and disked the summer before the experiments were initiated and winter wheat was seeded the preceding fall (1962 for one experiment and 1963 for the second).

Four years of the untreated continuous wheat allowed that stand of field bindweed to increase 47% in spring wheat and 55% in winter wheat. However, when the crop was sprayed each year with 2,4-D and cultivated several times after harvest, the weed density was reduced 74% for spring wheat and 65% for winter wheat at the end of the first year. Repeated spraying and cultivation reduced the stand 97% in both crops at the end of the fourth year. Crop yield was reduced 6% for spring wheat and 8% for winter wheat during the first year but was increased 117% during the fourth year for spring wheat and 55% for winter wheat.

Four years of untreated wheat-fallow rotation allowed the bindweed stand to become as much as 50% thicker. Fallowing did not appreciably reduce the stand of weeds but prevented reinfestation. When post harvest cultivation was used the first and third years, stand reductions at the end of 4 years were 95% and 96% in the two crops.

Four years of an untreated spring wheat-sorghum rotation allowed the stand of bindweed to increase 32%. However, when the wheat was sprayed in the grain and cultivated four times after harvest and the sorghum was sprayed during mid-July the stand was reduced 74% in 1 year and 97% in 4 years. Wheat yield was reduced 6% in the first year and increased 29% during the third. Sorghum gave a better response to weed control and yield was increased 350% and 90% during the second and fourth years.

In the untreated wheat-sorghum-fallow rotation, the density of field bindweed increased 37% in 3 years. However, when wheat was sprayed in June and cultivated after harvest, the stand was reduced 74% in spring wheat and 65% in the winter wheat. When sorghum was sprayed during the second year, the stand of bindweed was reduced 10% in the spring wheat rotation and 20% in the winter wheat rotation. During the fallow year, the stand was reduced another 3 or 4% for a total of 90% elimination in 3 years.

Forage Crops, Cultivation and 2,4-D

Identical 4-year experiments were initiated in 1963 and 1964. The treatments included various combinations of forage crops (alfalfa, perennial grasses or sudangrass) cultivation, 2,4-D and wheat.

Crested wheatgrass sod was plowed and disked the summer before the experiments were initiated (1962 for one experiment and 1963 for the second).

Thirteen treatments included tillage with a one-way disk in June and four duckfoot cultivations at 2- to 3-week intervals between mid-June and mid-August, and fall seeding of a perennial forage crop--smooth brome, crested wheatgrass, and intermediate wheatgrass.

Two treatments included spring seeding of either crested or intermediate wheatgrass that was sprayed the first year and cut for hay during the second, followed by 2 years of fallow-wheat. Three treatments included 1 year of sudangrass and 3 years of wheat-fallow-wheat.

Forage crops were less effective than in previous tests. Treatments that included

alfalfa smooth brome, crested wheatgrass and intermediate wheatgrass for 4 years without any special weed control practice being applied, reduced weed stand about 20% the first year in this study, whereas the field bindweed stand was reduced about 40% at Scotland.

The field bindweed stand was reduced about 50% in 4 years when alfalfa was seeded after a season of intensive cultivation and harvested for hay during 3 successive years--much less satisfactory than the 90% reduction at Scotland.

The weed stand was not materially affected by treatments that included a season of intensive cultivation and 3 years of smooth brome or intermediate wheat grass, but it increased 55% in 4 years when crested wheatgrass was used.

In treatments, which included a perennial grass and application(s) of 2,4-D during the second year, the stand was reduced 92 to 98% in 2 years but there was little change during subsequent years.

When annual crops followed a perennial grass, the results were similar to those obtained in the annual crop experiments. Stands were reduced materially when wheat was sprayed in the grain and cultivated after harvest. Fallow was not effective.

Nonselective Herbicides Post Harvest

Two 1-year experiments were conducted. In 1963 spring wheat was sprayed with 2,4-D on June 5. Dicamba and 2,3,6-TBA were applied August 8 (23 days after harvest) in the stubble.

Oats, spring wheat, and grain sorghum were seeded across each plot during 1964. Spring wheat was planted on all plots in 1965 and 1966 to determine effect of chemical residue on succeeding crops.

Evaluations made in 1964 indicated that the stand of field bindweed had been reduced 95% or more on plots treated with 4 pounds per acre of 2,3,6-TBA and 2 to 6 pounds of dicamba and that sorghum was not injured by herbicide residues. However, both oats and wheat were stunted by residues from all treatments. Stands of both small grains were reduced by dicamba residues--25 to 50% from 4 pounds per acre and 50 to 75% from 6 pounds per acre.

In 1965 there was no visible crop damage from residue of any of the herbicidal treatments made in 1963. Crop yields were not measured in 1965 but there was no measurable effect on yield in 1966.

The second experiment, initiated in 1964, was handled in the same manner except that 2,3,6-TBA and dicamba were applied at lower rates, and picloram was applied at several rates. Again, spring wheat was sprayed with 2,4-D. Fall applications of 2,3,6-TBA, dicamba and picloram were applied August 17 (25 days after harvest). Spring wheat and grain sorghum were planted across all plots in 1965 and wheat was planted on all of them in 1966. Crop damage was assessed by visual rating the first year and by yield checks in 1966.

Evaluations made in 1965 indicated that the field bindweed stand was reduced about 75% on plots that were sprayed twice with 2,4-D. Stand density was decreased 85 and 94% by 3 and 4 pounds per acre of 2,3,6-TBA, 90% by 1/2 to 2 pounds of dicamba, and 99% by 1/4 to 1 pound of picloram.

There was no visible effect on wheat grown during 1965 from chemical residue left by 2,4-D, 1/2 pound of dicamba, or 1/8 pound of picloram. There was slight stunting on plots treated with 1/4 pound of picloram; severe stunting on plots treated with 3 pounds of 2,3,6-TBA; and severe stunting and stand reductions of 50 to 75% in all other plots.

Likewise, there was no apparent damage to sorghum from residues of 2,4-D 1/2 or 1 pound of dicamba or 1/8 pound of picloram. There was stunting, however, on plots treated with 3 pounds of 2,3,6-TBA and stand reductions of 50 to 75% on all other plots. Two years after treatment, there was no stunting or stand reduction in wheat, but maturity was delayed several days.

Farm Discontinued

Several tours of the farm were conducted and a farmer field day was held in 1967, and the farm was discontinued after weed counts were made in June 1968. a 15-minute film, showing the results, was produced in 1967. The building was dismantled, moved to Brookings and erected on the weed section of the Agronomy Farm. Two years later it was again dismantled and disposed of.

CHAPTER XXXV ANNUAL WEED INVESTIGATIONS

Agriculturist E. C. Chilcott was concerned with weeds before the turn of the century. Botanists E. W. Olive and E.V. Peltry conducted weed control research and wrote bulletins on the subject in 1908 and 1924. Later, the personnel listed in the preceding chapter performed many experiments to study the effects of herbicides; ways of improving effectiveness of herbicides; and effects of the competition from weeds.

EARLY REPORTS

E. C. Chilcott reported in 1903 that weeds in the low lying college pastures had been removed by grazing sheep (Bul 81).

Many of the statements E. W. Olive made in 1909 about damage done by weeds, equipment needed for spraying, mode of action of a herbicide and principle of herbicidal activity appear in up-to-date publications.

Olive said, "No one needs to be told in this age of intelligent farming how it is that mustard and other weeds do harm. Nearly all farmers, especially those of the northwest, unite in regarding mustard as a 'yellow peril' (Bul 112).

"Weeds are harmful in many ways . . . They cut the crops of moisture, sunshine and soil food. They reduce yields and prevent filling and ripening. Rank growths keep leaves of crop plants moist which is conducive to infection by disease organisms (Bul 112).

"Until the farms . . . become smaller and more intensively cultivated, the weed problem will remain a serious menace. Careful cultivation of smaller fields will, of course, hold troublesome weeds in check. In the meantime, we must control the weeds in our large fields . . . the writer is firmly convinced that spraying with iron sulphate will help in this work" (Bul 112).

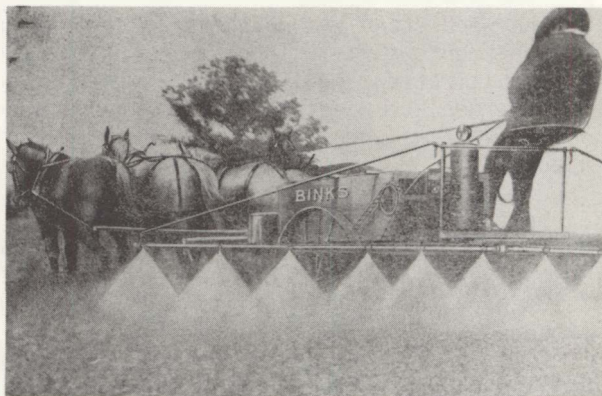
IRON SULFATE ON MUSTARD

In 1908 Olive applied iron sulfate to control weeds in small grains. American Steel and Wire Co., Chicago, Ill., furnished the chemical, sprayer and an "expert." Spraying was done on Kaator Brothers Ranch, near Castlewood, the O. B. Slentz farm near Milbank, the Isaac Lincoln Ranch near Aberdeen and on farms near Arlington and Brookings (Bul 112).

A 100-pound sack of iron sulfate was dissolved in 50 gallons of water. The spray solution was then strained through several layers of cheese cloth into the sprayer tank.

The spray was applied at 80 to 120 pounds pressure through a boom that covered a 15-foot swath (Bul 112).

According to Olive, the best time to spray was when grain plants were 6 to 10 inches tall before mustard started to bloom. However, "fair" results were obtained by spraying after the mustard had been blooming for some time (Bul 112).



Spraying for weed control in 1908.

Effects Of Chemical

Shortly after spraying the sulphate dried on the leaves, leaving minute whitish flakes. In 2 or 3 hours there were many more or less translucent areas on mustard leaves that turned gradually blackish. The leaves wilted rapidly and appeared to be dead in about 24 hours. In a few days to a week most leaves fell, but the dry remnants of some remained on the dead stem (Bul 112).

He said, "In our experiments, observations were made on the effect of iron sulphate on many different kinds of weeds. Those which were entirely killed under favorable conditions of spraying were wild mustard, small ragweed, giant ragweed, hedge bindweed, marsh elder, milkweed, annual peppergrass, pigweeds and sweetclover. Those which were more or less badly injured were Russian thistle, sunflower, dandelion, dock, biennial thistle, white clover, red clover and alfalfa. Those which were but slightly injured were plantain, sheep sorrel, prairie rose and lambsquarters. Grasses in general, including the grains (wheat, oats, corn, barley and speltz in our experiments) were not seriously injured" (Bul 112).

Herbicidal Activity

Olive believed that plasmolysis and/or disiccation caused the weeds to die. "The

main action (of the chemical) seems to be that the water in the leaf is drawn out of the cells by the flakes of salt dried on the surface . . . Common table salt . . . acts in a similar manner . . . Plasmolysis of the . . . leaves results . . . Plants wilt and die if water is drawn out of their leaves . . . After water is drawn out, some of the chemical may be absorbed, but this action is not the primary cause of death (Bul 112).

"Grasses and grains suffer a setback, but they soon pick up again. They undoubtedly owe their freedom from permanent injury to their habit of indeterminate growth. Their young leaves . . . growing from the base . . . have smooth surfaces . . . point upwards and shed the water (spray)" (Bul 112).

WEED CONTROL AND IDENTIFICATION

E. J. Peltry, consulting botanist, wrote a bulletin in 1924 which included line drawings and descriptions of 46 weed species. He also emphasized the losses caused by weeds and discussed principles of weed control as well as suggesting some control methods.

Losses Caused By Weeds

"If the real damage done by weeds were appreciated", Peltry wrote, "greater effort would be made to destroy them. Good tests of this damage are seldom seen by farmers and others; hence, few realize how great the losses are (Bul 211).

"For the state and nation, the losses run into unbelievable millions of dollars each year. Average losses for the United States have been reported to be 10% for corn, 10% for hay, 8% for potatoes, 12 to 15% for spring grains, 7% for winter grains and 20 to 25% for pasture. But these are far too low for many states, including South Dakota.

"Such amounts saved annually would make a difference between profit and loss, between success and failure, on many farms. These estimates are in general far too low for the reason that the damage by plant and animal parasites, harbored by these weeds, is estimated as insect and fungus losses. Animals lost or stunted by poisonous weeds are not included. Nor do these figures represent dockage losses on milk and its products, on grain, wool and grades of livestock (Bul 112).

"Many cases are known where the loss of over 50% of the annual production of whole farms was due to weeds which could have been completely controlled with little more labor than was actually but improperly spent (Bul 211).

"The experience of careful observers has shown that in single fields, the damage may be small in some instances, while in many cases it may mean a total loss. It has meant the loss of the right to certify seed or, in some cases, has brought on a costly lawsuit. In foods and feeds, weeds and weed seeds have caused unsalability of dairy products, human sickness, and many deaths. Much livestock is lost or stunted each year in this way. The pollen from about half of our weeds causes many cases of hay fever. Far more than the loss of time and labor on a field has resulted from the neglect of weeds" (Bul 211).

Principles of Weed Control

Peltry stated that there were many different kinds of weeds and soils, each calling for a different control treatment, but "there are general principles and facts underlying their control, which are common to their control (Bul 211).

"In all cases, the length of life, kind of growth and seeding habits must be considered. Then the cropping system and nature of the soil must receive some attention. After this, the special methods of control can be selected to better advantage as to cost and convenience" (Bul 211).

He described the life cycles of annual weeds, winter annuals, biennials and perennials, gave examples of each and indicated how effectiveness of control methods were influenced by life cycle. Seed dispersal by wind, water, machinery, trucks and railroads was discussed for several types of seeds or fruits (Bul 211).

Control Measures

Recommended control measures included the use of clean seed, boiling of screenings used for feed, burning stubble, fence rows etc., cutting before seeding, spraying with iron sulphate, pasturing with sheep, plowing at the proper depth, cultivation of row crops, crop rotation, competitive crops, cleaning the seeding and harvesting equipment and others (Bul 211).

2,4-D ON SMALL GRAIN 1946-1949

In 1946 L. M. Stahler and Lyle A. Derscheid, sprayed a wheat field six miles east of Scotland on the Maxwell Hutterite Colony, which at that time was owned by the Metropolitan Life Insurance Company. A few days later an oats field in the Tom Voy farm, northwest of Scotland, was sprayed. Several forms of 2,4-D were each applied at several rates of application.

Treatments similar to those used in 1946 were applied to oats on the Tom Voy farm in 1947, and on the Art Derscheid farm 6 or 7 miles northwest of Huron.

Poor weed control was obtained on some plots and some crop damage on others.

Stahler was USDA Coordinator for Minnesota and the Dakotas. He arranged for a meeting with Dr. E. A. Helgeson of North Dakota, Professor R. S. Dunham of Minnesota and Derscheid. They agreed that there was much to learn about the effects of 2,4-D on crops and also agreed that Dunham would conduct experimentation with flax, Helgeson with spring wheat and Derscheid with oats and barley.

Differential Responses of Barley Varieties to 2,4-D

Derscheid tested Spartan, Plains, Feebar, Kindred, Odessa, Manchuria and Barbless barley varieties for their responses to 2,4-D treatment in 1947, 1948, and 1949. Experiments were conducted on the Field Bindweed Research Farm during the first 2 years and on the Horticulture Farm at Brookings in 1949.

Ester, amine and sodium salt forms of 2,4-D were applied at the 5-leaf, fully tillered, heading and milk stages of growth. Yield and seed viability data were obtained each year. Seed weight was determined the last 2 years, number of spikes per foot of plot was determined, and the number of seeds per spike was calculated the third year.

The ester was more toxic to barley, as indicated by yield reductions and frequency and severity of morphological malformations, than were the amine or sodium salts. Of the two salts the amine caused the formation of more abnormalities in 1947, but there was no other indication of a difference in their effect on yield.

Sharp yield reductions of Plains, Feebar, Kindred and Moore in one year and of Barbless in all 3 years resulted from the application of the ester suggesting that Barbless, at least, and perhaps Moore, were more susceptible than such varieties as Spartan, Odessa, Manchuria and Tregal.

Stage of growth was the most important single factor affecting injury. Barley was most susceptible at the 5-leaf stage followed by the heading, fully tillered, and milk stages, respectively. There was little or no injury at the milk stage.

The yield of barley in 1949 was closely associated with the number of seeds per spike. However, the yield reduction of the late

varieties treated at the 4-to 5-leaf stage was partially caused by a decrease in the number of spikes.

The frequency of morphological malformations was increased by the application of 2,4-D. Vegetative abnormalities and derangement of florets were produced at the 5-leaf stage and the arrangement of florets was affected at the fully tillered stage. Blasting of florets and some lodging was caused at the heading stage.

In this study 195 abnormal spikes were selected in 1948 from plants that had been treated at the 5-leaf stage. Between 25 and 30 spikes were taken from each variety--about half from ester-treated plots and half from plots treated with either the amine or sodium salt. Each spike was threshed separately and the seeds planted in head-rows in 1949. These rows were observed for abnormalities and harvested. The bulked seed from each head-row was planted in a single row in 1950, and plants were again observed for malformed spikes. No spike malformations were observed either year, indicating that the abnormalities were not transmitted to the first or second generation of progeny through the seed.

The yield of barley varieties was reduced by treating at the 5-leaf stage of growth with an ester of 2,4-D. Seed produced on these treated plots and seed produced on untreated plots in 1948 were planted in 1949. Likewise, seed grown on untreated and ester-treated plots in 1949 was sown in 1950. It was not established that the yield of any variety was affected by treatment the previous year, indicating that reduced yield was not transmitted to the succeeding generation through the seed.

Differential Response of Oats Varieties to 2,4-D

Derscheid tested Brunner, Trojan, Mindo, Richland, Vikota, Tama, Clinton, Bonda and Marion oat varieties for their responses to 2,4-D treatment in 1947, 1948 and 1949. Andrew was added to the study in 1949. Experiments were conducted at the same locations as the barley varieties. The same treatments were applied at similar stages of growth. The same data were obtained with essentially the same results.

Stage of growth was the most important single factor. Yield was reduced 15 to 20% by treating at the 5-leaf stage, 5 to 10% at the fully tillered and heading stages and little or none at the milk stage. "Onion leaf" effect was caused by treatment at the 5-leaf stage with the ester.

The yield of oats was closely associated with the number of seeds per panicle.

Although the ester form of 2,4-D had an effect on panicle number and seed weight, these changes were not closely associated with yield.

Mindo was the most susceptible variety tested, but Marion, Tama, Clinton and Bonda were more susceptible than Brunner, Trojan, Richland and Vikota. Andrew could not be properly evaluated.

Oats were more tolerant than barley at certain stages. Oats yield was not consistently affected by the 2,4-D salts, but barley yield was reduced at the 5-leaf and heading stages of growth.

Reduced yield of oats was not transmitted to the progeny through the seed.

Physiological and Morphological Responses of Barley to 2,4-D

Two experiments were conducted by Derscheid--the first one at Brookings and the second at Ames, Iowa--to study the effects of 2,4-D on the physiology of barley when applied at different morphological stages of growth.

An early and late variety of barley were each treated with an ester of 2,4-D at nine stages of growth. Plains was used as the early variety each year and Wisconsin 38 as the late variety in 1949, but Moore was substituted for it in 1950. The 2,4-D was applied at 3-day intervals beginning at the 4- to 5-leaf stage, and growing points were dissected to determine the exact stage of growth treated. Yield, seed-weight and number of spikes were determined and number of seeds per spike was calculated each year, while seed viability data were obtained the first year.

Numerous developmental stages of growth were affected by the application of 2,4-D. Each stage existed for a relatively short time.

The most susceptible period of growth occurred before the 5-leaf stage, when the differentiation of tiller buds was inhibited by the application of 2,4-D. The number of tillers was reduced, the number of spikes decreased and yield greatly depressed.

A relatively tolerant second period of growth extended from the 5-leaf to the early boot stage. The heavy application of 2,4-D inhibited floral initiation, decreased the number of seeds per spike and lowered the yield. In a dry year there was a large yield reduction at the time of rapid differentiation and little or no decrease between periods. In a cool year, floral initiation was slow and a small decrease in yield was obtained over a 2-week period.

A relatively susceptible third period existed between the pre-heading and late heading stages. Yield reduction was due to a decreased number of seeds, which may have been the result of an inhibition of embryo sac and gamete development, or an increased vegetative competition as the result of stunting the central culm.

The most resistant period of growth in barley was a post-heading period when relatively heavy applications of 2,4-D did not decrease the yield.

The frequency of morphological malformations was increased by the application of 2,4-D. Vegetative abnormalities occurred during the first period, while the arrangement of florets in the spike was affected in the second period, and blasted florets were caused during the third period.

Seed viability was not impaired by the application of a heavy rate of 2,4-D at any of nine stages of growth.

2,4-D ON CORN 1946-1947

Stahler and Derscheid applied 2,4-D to corn on six dates in 1946 (June 1 and 15, July 1 and 15, fully silked and roasting ear) on the Field Bindweed Research Farm. Root malformations were noted on some plants.

The next year they sprayed three replications of nine hybrids at the same location. They applied two rates of 2,4-D sodium salt at each of two stages of growth--6 inches tall and right after layby cultivation when about 2 feet tall. Five plants from each plot were exhumed and examined for abnormalities. A few plants of three hybrids sprayed with 1/2 pound of 2,4-D when 6 inches tall were brittle at the soil surface and broke off. The fusing of brace roots occurred on some plants of all hybrids from at least one treatment, but was most prevalent on plants sprayed with 1 pound of 2,4-D after layby.

2,4-D ON SORGHUM 1949-1951

Stahler and James R. Hay sprayed 13 sorghum varieties and 13 advanced sorghum lines in 1949 on the Field Bindweed Research Farm. They applied three rates (1/4, 1/2 and 1 lb) each of 2,4-D amine and 2,4-D ester in three replications when the crop was 6 inches tall. They found no effect on yield of forage or grain.

The next year they sprayed Rancher, Norghum and Martin sorghum varieties (early, medium and late maturing, respectively) at Brookings.

They applied 3/4 pound of 2,4-D ester on 15 dates. First treatment was made when plants were 10 to 15 inches high; the second 2 weeks later at the 6- to 8-leaf stage and the remainder at 3- to 4-day intervals.

All varieties suffered root injury and reduced yield from treatment on the 2nd to 7th dates of treatment--especially the 3rd and 4th dates. Grain yield and the number of tillers were reduced by treatment when 10 to 15 inches tall. Yield was also decreased by treatment during pollination.

Derscheid repeated the experiment in 1951 except that he omitted Rancher, a forage variety. He concluded that the number of seeds per head had a direct bearing on grain yield and that both were least affected by 2,4-D when applied during heading or after pollination.

EFFECTS OF HERBICIDES ON SOIL MICROORGANISMS 1948-1950

Eight herbicidal chemicals were studied by Donald E. Kratochvil. They were an amine salt of 2,4-D at four rates ranging from 1 to 4 pounds per acre, 2,4, 5-T at rates of 1 to 16 pounds, sodium salt of pentachlorophenol (PCP) at 2 to 16 pounds, sodium salt of trichloroacetic acid (TCA) at 10 to 150 pounds, isopropyl-N-phenylcarbamate (IPC) at 4, 8, or 16 pounds, 2 dichloralurea at 2 to 8 pounds, sodium 2,4-dichlorophenyl "cellosolve" sulfate at 1 to 8 pounds and disodium 3,6-endoxohexahydrophthalate (Endothal) at 1 to 8 pounds per acre. All rates were calculated on an active ingredient basis.

Each rate of each herbicide was applied to 100-gram soil samples, containing 35% moisture, in Erlenmeyer flasks and incubated in a constant temperature water bath at 30.5°C. Following a short period of incubation to activate microorganisms, the flasks were closed and incubation continued.

Determination of gas pressure evolved through the activity of the soil borne bacteria and fungi were made after 52, 56 or 60 hours of incubation with a mercury manometer.

Relative effect of the several chemicals at the various rates of application was established by analyzing data comparing gas pressure evolved from treated soils, with similar determinations recorded for untreated soil.

The eight chemicals fell into three categories. Significant reduction in soil microbial activity was caused by PCP, IPC and dichloralurea, but TCA caused an even larger decrease.

No significant influence on relative micro-organic activity was indicated by 2,4-D, 2,4, 5-T or Endothal at the rates of treatment included in the study.

A stimulatory effect on microbial activity was indicated by sodium 2,4-dichlorophenyl "cellosolve" sulfate. The degree of stimulation increased with increases in amount of chemical applied. At 8 pounds per acre the increase was significant.

Kratochvil's report may be the first paper on weeds from South Dakota to be published in a scientific journal. It was one of the first papers printed in *Weeds*, the journal of the Association of Regional Weed Control Conferences that eventually became the Weed Science Society of America. His paper appeared on pages 25-31 in Vol. 1, No. 1.

AERIAL APPLICATION OF 2,4-D 1952-1954

During the late 1940s most 2,4-D applications were made in 40 or more gallons of water per acre. For field application, this was at least 0.8 of a barrel of water per acre. Sprayers were available that would accurately distribute as little as 5 to 10 gallons per acre and farmers wanted to use lower volumes. At the same time pilots were mounting sprayer equipment on their light planes. Most only carried a pay load of about 60 gallons. They were equipped to apply one gallon of spray per acre. In fact, 168,000 acres of small grain, including 120,000 acres of wheat, were aerially sprayed in 1953 which was similar to the acreage sprayed for the previous 2 or 3 years. Many of them were using diesel oil instead of water as a carrier.

Spraying recommendations obviously did not meet their needs. It was necessary to learn more about the application of 2,4-D in low volumes of carrier, with an airplane and with oil as a carrier. Standard Oil Co. sold 2,4-D and diesel oil and agreed to furnish the herbicide, the oil and funds for graduate assistantships.

Keith E. Wallace conducted a preliminary experiment on the Ike John Ranch near Strool in 1952. A year later a larger experiment was conducted at Strool and at Huron.

The 1952 experiments included one 2,4-D formulation on duplicate 1- by 5-rod plots, for ground and 45-foot by 5-rod plots for air. The 1953 experiments included two formulations on quadruplicate plots.

In 1954 Russel L. Nash conducted similar experiments at both Strool and Huron. Six replications were used on plots 20- by 80-feet

for ground and 50- by 60-feet for air applications.

To compare volumes and carrier 1/3 pound per acre of a 2,4-D ester was applied by airplane in 1/2 to 5 gallons of water or 1/2 to 5 gallons of oil per acre.

To compare formulations and method of application, two 2,4-D esters were applied in 1953 at four rates (1/8 to 3/4 pounds per acre) in one gallon of oil by air and 10 gallons of water by ground. In 1954 a single rate of 1/3 pound was applied in one gallon of oil or water by air and 10 gallons of water by ground.

Thirty-four aerial treatments and 25 ground treatments covered 15 acres in 1953. Not quite 11 acres were needed in 1954.

Spray retention studies were conducted by both Wallace and Nash. Blue dyes were mixed in the spray solutions. Immediately after spraying, 3 square yards of wheat were harvested from each plot and washed with 400 milliliters of the carrier (oil or water) used in the treatment. Samples of the wash solution were run through a colorimeter to determine the concentration of the wash solution. This concentration gave an indication of the amount of spray retained by the crop.

Also at the time of treatment a strip of adding machine tape was placed across the spray path of each plot in which spray retention samples were taken. They served to determine if wind moved aerial applications outside the desired area and to indicate the uniformity of the spray pattern.

At harvest time sunflower injury readings of 0 to 4 were recorded and 5 square-yard-samples of grain were harvested from each plot and threshed. Yield and test weight were calculated.

Volume of carrier per acre had little effect on yield of wheat, percentage of spray retention or weed kill. There were no differences between airplane and ground applications on either yield, percentage spray retention or effect on sunflowers, even though airplanes produced larger droplets and did not appear to give as uniform coverage.

There were no differences between oil or water as carriers on yield, percentage of spray retention or control of sunflowers. Three formulations of 2,4-D ester had similar effects on wheat yield, spray retention and weed kill.

Nash also compared aerial spray drift from 2,4-D ester in oil, 2,4-D ester in water and 2,4-D amine in water. Potted tomato plants,

used as a bio-assay, were lined parallel with the wind at 20-foot intervals for a distance of 560 feet. A different set of plants was used for each spray mixture. An aerial sprayer, Al Nelson, sprayed cross wind 60 feet from the upwind end of the line of plants. The most severe damage was 15 to 20 feet upwind from the center. This was the left side of the plane. Prop wash normally caused a heavier deposit on that side. The drift for the ester, whether in oil or water, was more concentrated 500 feet downwind from the center of the spray swath than that of the amine 260 feet downwind.

WEED CONTROL IN CORN 1948-1956

Kratochvil and Derscheid applied herbicides to corn for weed control in 1948 on the Agromony Farm at Brookings. Ortho secondary amyl phenol (dinitro) and 2,4-D amine were each applied at three rates at seeding time, 3 days after seeding and 6 days after seeding. 2,4-D amine, at three lower rates, and PCP, at three rates, were applied when corn was 14 inches tall.

The 2,4-D did not affect corn yields and reduced stand of broad-leaved weeds when applied post-emergence. A rate of 4 pounds reduced the stand of foxtail about 50% when applied 6 days after seeding.

In 1954 Derscheid applied a dinitro, an experimental herbicide Crag EH 1 and a mixture of 2,4-D and TCA sprays were directed to the base of the corn at layby on the Horticulture Farm. The 2,4-D and TCA gave 95% and 4 pounds of EH 1 gave 87% foxtail control.

By 1956 many new herbicides were available. Some were applied to 2-row plots pre-emergence, others at the 2-leaf stage and others at layby. Good control of foxtails and several species of broad-leaved annual weeds were obtained by applying CDAA pre-emergence and cultivating afterwards. DNBP (a dinitro) was effective at the 2-leaf stage. TCA controlled foxtail that was less than 6 inches tall while dalapon and ATA controlled it at later stages of growth. Several urea compounds were not satisfactory.

2,4-D ON ANNUAL WEEDS 1951-1953

Several reports indicated that ruminant livestock suffered from nitrate poisoning after having grazed forage that had been sprayed with 2,4-D. However, chemical analysis of forage from sprayed pasture and unsprayed forage outside the pasture failed to confirm that potassium nitrate (KNO_3) content was affected by the herbicide application.

Nevertheless, Derscheid conducted an experiment each year from 1951 to 1953 on the Horticulture Farm in an attempt to learn if the KNO_3 content of weeds was affected by treatment with 2,4-D.

Proso millet, foxtails, wild mustard, small ragweed, kochia, Russian thistle and rough pigweed were planted in 5- by 5-foot plots in 1951. 2,4-D was applied at rates of 1/8, 1/4 and 3/8 pound per acre on triplicate plots. Samples were harvested 3, 8, 14 and 19 days after spraying and analyzed for KNO_3 content by the Biochemistry Department.

The experiment was modified in 1953. The same species were planted but some of the, kochia, small ragweed, wild mustard, foxtails and sugar beets (one addition) were each planted on unfertilized plots and on plots that were fertilized with ammonium nitrate.

In general there was little affect on the KNO_3 content of weeds sprayed with 2,4-D. The content was essentially the same from 3 days to 3 weeks after spraying, but KNO_3 content of weeds growing on high nitrogen soils was higher on untreated as well as on sprayed weeds. It was highest on the first date of sampling and gradually declined each successive date, but was still several times higher than from unfertilized weeds.

WEED CONTROL IN LEGUMES 1949-1959

Kratochvil and Derscheid sprayed sweetclover underseeded in oats on the Field Bindweed Farm in 1949. Three forms of 2,4-D and 2,4,5-T ester were each applied at two rates when the clover was 6 and 18 inches tall. The best clover stands were obtained on plots sprayed with only 1/4 pound of 2,4-D amine when the crop was 6 inches tall. The stand was reflected in the 1950 hay yields.

Sweetclover underseeded in both flax and oats was sprayed on 5- by 15-foot plots on the Horticulture Farm in 1952. The chemicals used in 1949 and MCPA, TCA, IPC, CIPC, Endothal and Selective Dinitro were applied when the clover was 6 inches tall.

CIPC and high rates of Endothal, MCPA, 2,4,5-T and dinitro reduced flax yields. The dinitro and 1/2-pound rates of 2,4-D, 2,4,5-T and MCPA reduced oat yields. Though 1953 yields of sweetclover ranged from 1.6 to 2.3 tons per acre, none were significantly different than the yield from unsprayed plots.

Four experiments which included 102 5-by 15-foot plots were sprayed with various chemicals at Brookings in 1954. Sweetclover was underseeded in flax and in oats in two experi-

ments and alfalfa was underseeded in the same crops in two others. Weevils and/or chemicals killed the sweetclover on all plots. The results indicated that alfalfa would tolerate 1/4 pound per acre of 2,4-D amine or MCPA amine or 1 pound of dalpon when the cover crop was 10 inches tall.

In 1959 alfalfa was planted at Brookings as a solid seeding and in rows. Spray treatments included simazine applied the previous fall and immediately after seeding. 2,2-dichloropropionic acid (dalapon) and 2,4-DB were applied seperately and in mixtures when seedlings were 3 inches tall. Stand evaluations in 1960 showed over 90% stand from all treatments except the 1-to 4-pound rates of simazine applied immediately after seeding.

RESEARCH EQUIPMENT AND TECHNIQUES 1946-1956

Neither the Agronomy Department nor USDA owned any small plot equipment or spraying equipment except for a couple of knapsack sprayers. In 1946 the Metropolitan Life Insurance Company borrowed a Fargo field sprayer that was used at Scotland. The next year the Peavey Company brought an especially built plot sprayer to South Dakota that was used at Scotland and Huron. At that time Derscheid decided to have a field plot sprayer built.



A Fargo Foundary Sprayer.

The oats and barley varieties were planted with a grain drill at Scotland using 6-inch row spacings in 1947 and 12-inch spacings in 1948. Four 12-foot rows were harvested by hand in 1947, using shears to clip the heads which were put in paper bags, transported to Brookings, dried and threshed.

A Jari mower with 3-foot sickle bar was purchased for \$228 in 1948. The sickle bar was shortened and a hopper attached to catch the straw from the center two 14-foot rows of the 4-row plots. A bundle from each plot was inserted head first into a paper bag, dried and threshed in a Keystone thresher that had been purchased for \$473.

The procedure was the same in 1949 except that seeding was done with the 4-row seeder borrowed from the small grain breeders.

A team and 2-row corn planter were borrowed

from Tom Voy to plant the corn in 1946 and 1947. At Brookings, corn was planted by hand in 1948, but the Agronomy Farm 2-row planter was used in 1954 and 1956. Sorghum was planted with a Planet Jr., 1-row garden crop seeder.

All spraying was done with a knapsack sprayer until 1951. After that date the bicycle sprayer was used. Three nozzles were used for 5-foot plots and 4 nozzles for 7-foot corn plots.

Ike John and Walter Ball provided the airplanes and did the flying for aerial applications. John also provided the tractor, a DC-6 International, to pull the trailer sprayer for ground applications in 1952 and 1953, but the Pony tractor and sprayer were transported to the research sites on the flatbed machinery trailer in 1954.



Aerial spraying for weeds in early 1950s.

WILD OATS CONTROL 1958-1960

Wilford H. Wallace conducted a four-part study on methods of controlling wild oats. The first part was to determine if a particular practice would affect the establishment of wild oats. Wild oats yield data were obtained during 1957 and 1958 and stand data during 1959 from plots that had been seeded to wheat containing wild oats seed during 1947 and devoted to several types of rotations during the intervening years.

The second part, conducted on the Thistle Research Farm, was to determine the effectiveness of several cropping and tillage practices for eliminating wild oats by obtaining yield and plant density data from experiments designed originally to control Canada thistle.

The third part was to compare the effects of a duckfoot cultivator, one-way disk and disk harrow, used in mid-September, early and late October upon spring germination of wild oats by making early spring wild oats plant counts during 1959.

The fourth part was to determine the effect of avadex, 2,6-dichlorobenzonitrile and car-

byne on wild oats and crops of wheat and flax by taking crop yields and wild oats stand counts in experiments conducted on private farms near Castlewood, Wilmot and Claire City in 1959.

Rotations on the Thistle Research Farm, which contained corn and clover or 2 or more years of grass prevented the establishment of wild oats, but a rotation of corn, oats and wheat did not. Clipping of alfalfa and brome-grass the year they were established reduced the stand of wild oats. Alfalfa and brome-grass seeded in mid-August following spring and summer cultivation was more effective than when spring seeded. Plowing in October reduced the number of wild oats more than a plowing in August followed by cultivation. Plowing in September was not consistent in its effect.

Pre-emergence application of Avadex and 2,6-dichlorobenzonitrile controlled wild oats, but reduced the yield of wheat and flax.

Carbyne was most effective in controlling wild oats if applied when the weed was between the 2- and 3-leaf stages of growth. Wheat was tolerant of 1/2 to 1 pound of Carbyne per acre, but flax yields were reduced by rates of over 1/4 of a pound.

WEED CONTROL IN ROW CROPS 1957-1970s

In 1957 the screening of herbicides for weed control in corn and soybeans became an annual activity. Sorghum was included in 1957 and from time to time after that. Sunflowers were included after the mid-1970s.

The herbicides tested in 1957 included pre-emergence applications of simazine, ethyl-N, N-di-n propylthiocarbamate (EPTC), 2-chloro-4-6-bis (ethylamino) s-triazine (CDAA) and CDAA granules and an early post-emergence treatment with DNBP. Corn and soybeans were seeded in 6-row by 115-foot plots. One crop was put in each seed box of the used 2-row corn planter, purchased in 1957, for \$148 to be used on these plots and for planting corn on the perennial weed research farms. Each plot contained three pairs of rows (1 corn and 1 soybean). The bicycle sprayer did not push



Planting corn and soybeans at Brookings.

easily through the loose soil so the trailer sprayer, with a 20-foot boom, was used to apply sprays to all six rows. One pair of rows was not cultivated, but a 2-row cultivator was used to cultivate one pair twice and the other pair three times. Sorghum was planted in a separate experiment.

None of the herbicides caused any damage to corn, but soybeans were injured by 4 pounds per acre of simazine and killed by DNBP. Sorghum was injured with 4 pounds of DNBP. Six pounds of CDAA granules and 4 pounds of simazine gave 90% weed control, while 2 pounds of simazine gave 60%. The other treatments were unsatisfactory.

This system was followed for several years with corn and soybeans. However, a granular applicator was attached to the corn planter in 1958 for application of granular forms of EPTC and CDAA. Also, dalapon, a grassy weed herbicide, was applied as a directed spray at the base of corn plants on uncultivated plots.

The use of outlying tests was initiated in 1958 when sprays of simazine, EPTC and CDAA were applied in corn on the Ervin Syverud farm 10 miles southwest of Canton.

New herbicides were added to the test each year (atrazine in 1959). Plot length was reduced to 56 feet in order to conserve space.

In 1959 and 1960, however, Wilford Wallace used the newly developed logarythmic sprayer to apply a wide range of concentrations on a single long plot. Though more rates and dates of application could be tested on the same sized area, it was difficult to accurately evaluate the weed control.

During the late 1950s half of the area used for these tests was plowed the next year and half was disked. Oats and wheat were each planted on half of each tillage treatment to determine the residual effect of each herbicide on a succeeding crop. In 1961 Wallace planted several crops (alfalfa, barley, corn, flax, sorghum, soybeans and flax) on the area used for screening tests in 1960.

Effects of Environment on Pre-Emergence Applications

By 1958 it became apparent that the amount of rainfall and the amount of cultivation after the pre-emergence applications of herbicides had an effect on the results.

Walter E. Splittstoesser correlated results obtained by Derscheid from pre-emergence applications of several rates of CDAA, simazine and atrazine, made at Brookings from 1956 to 1961 and at Canton in 1958, with greenhouse trials.

Foxtails were the predominant species of weeds. Observations were made at weekly intervals for 8 to 10 weeks after treatment to determine speed of kill and length of residual period. Estimates of the percentage of foxtail control were made approximately 6 weeks after treatment and again near September 1. Rainfall and temperature data were recorded for 2 weeks before treatment and 4 weeks afterwards.

Splittstoesser conducted greenhouse trials during 1958 and 1959. During the first year, 400 green foxtail seeds were planted at a 2-inch depth in greenhouse flats. In 1959, 15 grams of seed were mixed with the soil in the same flats. Tap water was applied at rates of 1/2- or 1-acre inch per acre with an oscillating boom to stimulate rainfall. Water was applied before application of herbicide or 1, 7, 14 or 21 days afterwards. Beginning one week later, enough water was applied at semi-weekly intervals to promote growth of the weeds.

The number of living plants in each flat was counted at weekly intervals. Although weeds emerged and grew before the later simulated rainfall treatments were made many plants were killed during the week after 1/2 or 1 inch of water was applied. Final counts were made 4 to 5 weeks after herbicide application.

Water moved CDAA, atrazine and simazine into the soil. It leached the herbicide into dry soil but the herbicide movement was along a concentration gradient in wet soil.

Pre-emergence applications of 4 to 6 pounds per acre of CDAA controlled foxtail effectively if applied to warm soil and if normal amounts of rain fell within 7 to 10 days. The effectiveness of sprays was reduced if applied to wet soil, if less than 1/2 inch of rain fell the first week after application, or if a heavy rain fell immediately after application. Granules were effective under similar conditions but this effectiveness was not impaired by application to wet soil or by a heavy rain immediately after treatment.

Pre-emergence application of 2 to 4 pounds per acre of simazine as sprays or granules controlled foxtail if applied to wet soils, if one inch of rain fell within 15 days after application or if 3/4 inch of rain fell during each of 2 weeks after treatment. Fair to good results were obtained when one inch fell during the third week. Under these rainfall conditions weed control was maintained all summer by 4 pounds but larger amounts of rain shortened the period of weed control.

Rates of 3 to 4 pounds per acre of atrazine controlled foxtail if 1/2 to 1 inch of rain

fell within 15 to 20 days after application. The period of residual weed control was shorter than for simazine and was reduced to a greater extent by heavy rainfall.

Later Field Tests

When Derscheid joined the Cooperative Extension Service on a half-time basis on March 1, 1960, W. H. Wallace was in the process of completing work for a M.S. degree, was added to the weed research staff. Though the two worked together on most activities, Wallace did most of the work with annual weeds. His successor, L. C. Warner, worked exclusively with annual weeds.

During the early 1960s tillage with disk, harrow and rotary hoe, was performed to enhance activity of pre-emergence applications.

The trailer sprayer was too cumbersome for use on small plots. Though the wheels could be spread far enough to straddle two rows, the axle was only about a foot above the ground making it impossible to spray corn that was much over 14 inches tall.

A Cub Farmall Tractor, with the engine mounted off center, was obtained in 1962. Derscheid and Wallace had a sprayer built on it. An auxiliary motor and pump were mounted beside the tractor motor. Two 5-gallon aluminum spray tanks were mounted over the rear wheels; a larger tank used as a water supply and for flushing the system was located behind the seat; a speedometer was attached to a front wheel; and a 6-nozzle, 10-foot boom was built that could be mounted in front of the tractor or under it. This machine was more maneuverable than the larger sprayer and could be used to spray three rows at a time. By closing some nozzles, narrower plots could be sprayed.

After it was learned that corn would tolerate some herbicides that killed soybeans, the two crops were put in separate experiments and fewer herbicides were used in soybeans. The new tractor sprayer made it possible to spray at later stages of growth and more dates of application were included in the tests.

In 1963 Warner established the Southeast South Dakota Experiment Farm as a permanent location for screening herbicides for weed control in corn and soybeans. He also modified the tractor sprayer. He replaced the auxiliary motor and pump with an air compressor and replaced the larger water tank with four 2- to 3-gallon cylinders which were used as spray tanks. Air pressure was used, as on the bicycle sprayer, to force spray from any one of the cylinders to the boom.

Derscheid left the weed project July 1, 1964. At that time the weed budget from state and federal funds totaled over \$60,000 which financed all the research work except for the chemicals which were provided by the various manufacturers. However, the amount of state and federal funds for weed research began to diminish. The position of weed physiologist, held by John Dosland, was discontinued in 1967. The Assistant Agronomist position, held by Wallace and his successors, was downgraded to Assistant In Agronomy in 1969.

The perennial weed control program was all but discontinued. Under the leadership of J. Stritzke and W. E. Arnold, the screening of herbicides was increased and became a major weed research activity partially because they had to rely on grants from chemical companies for part of their finances and they conducted research that was of mutual interest to themselves and the grantors.

Warner, Stritzke and Arnold all had the responsibility of teaching a course in weed control. Arnold, because of his excellent teaching was assigned other courses as well and became a half-time teacher and half-time weed researcher.

During the 1970s screening trials were conducted annually on the Agronomy Farm at Brookings, the Southeast South Dakota Experiment Farm near Beresford, the Northeast Mobile Research Farm near Watertown and the James Valley Research and Extension Center near Redfield as well as at several West River locations. At the four permanent research locations, personnel at the site performed seeding and cultivation operations.

The budget from state and federal funds dropped to \$19,000 in 1975. At that time W. E. Arnold wrote:

"Herbicide testing is financed by commercial companies who want their experimental or commercial herbicides tested under South Dakota conditions. More than 500 different chemicals have been tested from 1950 to 1974. Each chemical is applied at different rates and dates of application to different weeds and kinds of crops or even different varieties of a crop to determine its effectiveness for weed control without damage to the crop. Thus, a large number of individual plots are sprayed each year and the effects assessed. For example, about 10,000 plots were sprayed in 1974.

"Most commercially-sold herbicides are developed for conditions in the more humid states where herbicide sales are largest. Many application rates of herbicides are higher in more humid areas than have been

found to be necessary in South Dakota. In addition, some chemicals recommended in more humid areas are ineffective in South Dakota so their use by South Dakota farmers is reduced by the testing program.

"The testing program determined which herbicides were effective for use in South Dakota. It determined the amount needed, the best date of application, the effects on crops and which weeds were controlled."

Though major emphasis was placed on herbicide testing, many other weed problems were studied by various graduate students.

COMPETITIVE EFFECTS OF WILD BUCKWHEAT

James D. Arnold in 1964 and 1965, studied the effects of different durations and intensities of wild buckwheat on spring wheat in three experiments--two in the greenhouse and one in the field.

In the greenhouse, three wheat plants were grown in pots with zero, three, six, and nine wild buckwheat plants per pot for periods of 20 to 80 days in one study and 10 to 80 days in the second. Wheat plants were harvested after 83 to 85 days and several types of data were obtained for each experiment.

A pot culture study also was used to study the competitive effects on wheat leaf area and vegetative dry weights when grown on four levels of weed density and four levels of fertility. Vegetative dry weights were obtained and leaf areas were estimated.

The competition from wild buckwheat reduced total plant weight, vegetative dry weight, number of kernels, and kernel weight of the wheat.

Plant height, number of tillers, and days required to reach anthesis of wheat were not greatly affected by wild buckwheat competition.

Reduction in area of wheat leaf was directly related to the density of weeds and the length of the period of competition. For most factors, however, the period of competition was more important than weed density. Wheat suffered most from buckwheat competition extended past 10 days.

OILS AS HERBICIDE CARRIERS

In 1965 K. R. Frost, Extension Weed Specialist, sprayed sorghum post emergence with atrazine in diesel oil. Previously, it had proven to be ineffective when applied post emergence, but when mixed with water and applied pre-emergence, it killed many annual

weeds. Frost showed that atrazine was also an effective herbicide when applied post emergence if oil was used as a carrier.



K.R. Frost applying granular herbicides pre-emergence on county row crop demonstration plots in mid-1960s.

James A. Peacock conducted an extensive study from 1967 to 1970 to learn more about oils and how they affected post emergence spray applications of herbicides. Two major problem areas were investigated.

The first dealt with specific physical and chemical properties of oils as they were associated with phytotoxicity and enhancement of herbicidal activity, while the second dealt with foliar penetration as a possible mechanism of enhancement.

Simple correlation and multiple regression analyses were conducted for specific properties of mineral oils applied to green foxtail and grain sorghum as 5% oil in water emulsions with and without 2 pounds per acre of atrazine.

Simple correlations identified individual oil properties important in explaining dry weight variabilities, but these single properties generally accounted for only a small portion of the total dry weight variability.

Analyzing eight oil properties by multiple regression analyses showed that the properties most highly associated with atrazine enhancement included distillation temperatures, pour point, viscosity, viscosity index, refractive index and flash point.

Phytotoxicity of oil alone was associated with increased aromatic contents and decreased unsulfonated residue values. These findings were slightly altered when natural (crop) oils were included with the mineral oils due to inherent differences in the properties of the types of oils.

Several oils used as 5% oil/water emulsions significantly increased the herbicidal activity of atrazine on foxtail and sorghum when compared to atrazine in water alone or with 0.1% surfactant. Penetration of ^{14}C from

atrazine and dicamba through astomatous leaf surfaces of *Tradescantia* was greater with an oil-water emulsion than with a 0.1% surfactant solution. Most of the radioactivity was located below the treated leaves of *Tradescantia* plants 1 day after treatment but accumulation in the plant parts above treated leaves increased by the 6th day. ^{14}C -labeled mineral oil penetrated and translocated in the *Tradescantia* plants. Uptake of ^{14}C from the oil increased from 20 to 57% in the first 6 days after treatment. Little additional uptake was noted in 15 days.

Measurements of CO_2 uptake by sorghum revealed that photosynthesis was completely inhibited 1.5 hours after treatment with atrazine in oil-water emulsion.

Maximum penetration of ^{14}C -labeled herbicides through isolated astomatous cuticles of

apricot leaves occurred at warm rather than cold temperatures when wax was removed from leaf surface prior to treatment. It penetrated from the air side of the cuticle to the mesophyll side rather than in the reverse direction. It penetrated more rapidly when the herbicides were applied in oil emulsions than when applied in water with 0.1% surfactant. Penetration of ^{14}C from dicamba was more rapid than absorption of ^{14}C from atrazine.

Autoradiographic studies using isolated astomatous apricot cuticles showed that cuticle areas over veins were preferred sites of entry for ^{14}C from oils in both pure and emulsified forms and for ^{14}C from dicamba regardless of carrier type. No preferred sites of penetration were found in cuticle areas directly above an individual cell whether the underlying cell was in a vein or non-vein area of the leaf.



Weed Committee 1967-70: (standing) L.A. Derscheid and F.C. Westin co-chairman; (sitting) E.E. Sanderson, Extension crops; L.J. Wrage, Extension weeds; and J. Stritzke, weed research.

CHAPTER XXXVI PLANT PHYSIOLOGY

Plant Physiology became an activity in the Agronomy Department in 1956 when the USDA stationed plant physiologist Charles R. Swanson at SDSC. Though others had taken plant physiology classes, Swanson was perhaps the first staff member actually trained in the field. His assignment was to study the physiology of alfalfa. Donald G. Kenefick, in 1959, became the first state employee trained in plant physiology and C. Dean Dybing, another USDA physiologist, initiated a flax physiology project in 1960.

In 1961, John Dosland was employed on the weed project with funds from a special federal appropriation. He studied the physiology of leafy spurge with emphasis on the subterranean parts.

Gerald Loper, another USDA physiologist, replaced Swanson in about 1962 and was located at SDSU for several years during the 1960s.

Personnel

Staff Members

Dr. C. R. Swanson (USDA)	1956-1960
Dr. D. G. Kenefick	1959-
P. M. Seevers *	1960-1962
Dr. C. D. Dybing (USDA)	1960-

Dr. J. Dosland	1961-1968
Dr. G. Loper (USDA)	1962-1966
Dr. A. K. Huff **	1975-1976

Graduate Students

Anthony A. Salomi	Ph.D.	1966-1968
Aurora Salazar	Ph.D.	1970-1972
Clay G. Johnson	Ph.D.	1969-1972

Ray Sze Chung Wong	Ph.D.	1971-7/75
Patricia Franke	M.S.	1977-1978
Thomas K. Blake	M.S.	8/79-

*Assistant in Agronomy

**Post-Doctoral Research Associate

WINTERHARDINESS

D. G. Kenefick was employed, initially, with federal funds. They were obtained by a crop physiology research committee composed of one scientist from each of the 13 Experiment Stations in the North Central States. Funds were allocated to the committee to study the physiology of winter hardiness. It decided that studies should be conducted with winter wheat and that SDSC would be a good location.

The following information was contained in

the notes compiled in 1976 by E. M. White for the bicentennial benchmark publication.

E. M. White

One of the critical periods for survival of winter wheat in the Northern Great Plains is the brief warm spell of late winter. Distinctions between hardy and less hardy cultivars is regarded as being partially related to the degree of meristematic activity initiated during these periods. Early growth initiation is fatal, if followed by severe freezing conditions. This growth is influenced by moisture, temperature and photoperiod. A slow response is viewed as a desirable feature of hardy plants, in which formation of growth initials is delayed until the risk of impending frost is past (Kenefick).

The process of selecting hardy plants is surmised, therefore, as favoring those with a longer growth response time. However, such plants also yield less grain which may be closely related to their photoperiod response. The extent to which yield, hardiness and photoperiod range are related in wheat cultivars has yet to be determined. These observations point to a possible dichotomy confronting wheat breeders selecting hardy plants (Kenefick).

An additional controlling factor is that of available soil moisture. It is suggested that winter wheat is more successfully grown in western than eastern South Dakota because of difference in soil moisture. Within certain critical limits, the lowered soil moisture of the western region functions as a limitation on these developmental processes during unseasonable warm periods. Even in this region, localized depressions in wheat fields frequently have the greatest winter-kill, again suggesting that soil moisture level is critical to survival. SDSU crop physiologists believe that an understanding of factors controlling meristematic activity in wheat plants is important to selecting high yielding hardy wheat and to the eventual development of techniques for regulating growth responses of plants (Kenefick).

FLAX PHYSIOLOGY

C. D. Dybing was employed to study the physiology of flax. His responsibilities were broadened in the mid-1970s to include all oil crops--flax, soybeans and sunflowers.

Agricultural Research Service personnel at SDSU have determined in cooperatively funded research that flax growth and yield are con-

trolled by air and soil temperatures, light intensity, daylength, moisture stress, cultural medium, carbon dioxide content of the air, and nitrogen available for growth. Cool air temperature is particularly important for high oil content and quality, whereas adequate moisture and nutrient supplies are critical

for high yields. Even in optimum environmental conditions, each plant has numerous flower buds which fail to develop and produce seed. Current tests will show whether hormonal plant regulators can be used as sprays to increase the length of time the plants flower and set seed and thus increase yield (Dybing).

CHAPTER XXXVII EXTENSION AGRONOMY

Research information about South Dakota agriculture becomes valuable when it is used to increase the efficiency of agriculture on farms and ranches. This information is disseminated by classroom teaching and Extension activities. The Extension staff prepares and releases radio and television programs, newspaper and magazine articles, fact sheets and circulars. In addition, they participate in many local educational programs and field days primarily organized by county agents. Research results from studies in other states and countries also are interpreted by Extension staff for use in South Dakota.

The information in this chapter was obtained from annual reports (most on microfilm) by Extension specialists, "Half Century of Progress of South Dakota Crop Improvement Association," written by Jason S. Webster in 1954 (JW), "History of South Dakota's Conservation Districts," written by Leonard L. Ladd in 1969 (LL), "History of Extension" written in 1977 (Ext), other Extension reports and personal memories.

Early Extension Activities

Crop production was the topic of Extension-type bulletins published by the Agricultural Experiment Station as early as 1889. During that year the State Legislature passed a law providing for Farmers' Institutes and farmers began to call on instructors at the South Dakota Agricultural College for assistance with their institute programs (A-91). Irrigation was specified as a topic in 1894 when the legislature made its first appropriation for the institutes (A-92). It seems logical to assume that other agronomic topics also were included on the programs. John S. Cole was active in Extension-type activities as early as 1906 and Clifford Willis as early as 1910.

After A. N. Hume became Head of Agronomy in 1911, there seems little doubt that he encouraged Agronomists to conduct educational programs. He said: "Knowledge is not knowledge until it is disseminated." In 1912 he suggested that demonstrations be conducted to show new farming techniques to farmers (Bul. 139).

Hume served as the first County Agent Leader from 1913 to 1915. During this period J. G. Hutton, Manley Champlin and Mathew Fowlds were also active in Extension-type activities.

EXTENSION SPECIALISTS 1920-1981

A total of 39 specialists includes 14 soils, 12 crops and seven weed specialists, two entomologists, one pathologist and one specialist each for watershed development, potatoes, irrigation and integrated pest management.

Crops

Manley Champlin	1916-8/31/1920
Ralph E. Johnston	9/1/1920-6/30/1938
Rex Bankert	6/30/1937-12/31/1938
U. J. Norgaard	2/16/1939-8/31/1958
Elmer E. Sanderson	7/1/1945-6/30/1973
Ralph A. Cline	11/1/1949-6/30/1972
Dr. Lyle A. Derscheid	3/1/1960-7/15/1979
Dr. Robert Hoeft*	7/1/1972-11/15/1973
Dr. James R. Johnson*	5/1/1974-6/30/1978
J. Duane Colburn	7/1/1973-6/30/1975
Dr. Robert Pylman	7/1/1973-6/30/1975
Dr. Donald J. Reid	8/1/1975-8/31/1981
Clair E. Stymiest*	7/5/1978-

Soils

Ralph E. Hansen	11/10/1938-4/30/1944
Leonard L. Ladd	7/1/1944-9/30/1956
Raymond L. Venard	11/20/1945-11/15/1946
Merle E. Switzer	10/1/1951-11/14/1957
R. Gene Gresham	9/1/1955-3/9/1957

Clarence Nelson	7/1/1956-1957
Ed J. Williamson	5/1/1957-9/30/1962
Lloyd E. Davis	1/1/1957-1/31/1963
Reinder Mesdag	3/15/1958-4/15/1959
Robert I. Papendick	4/1/1959-10/14/1959

Edward L. Langin	11/1/1962-6/30/1967
Earl P. Adams	2/16/1963-6/22/1978
Ed J. Williamson	7/1/1967-4/30/1979
Robert P. Schoper	1/15/1979-12/31/1980
James R. Gerwing	11/1/1980-

Weeds

Leonard L. Schrader	7/1/1948-6/30/1951
Lloyd R. Wilson	1/1/1952-6/30/1954
Keith E. Wallace	7/1/1954-4/30/1961
Kenneth R. Frost, Jr.	9/11/1961-10/31/1966
Robert Parker III	6/19/1967-8/19/1969
Leon J. Wrage	10/1/1969-
Clair E. Stymiest*	7/5/1978-

Watershed-Flood Control

Joseph T. Paulson	12/1/1954-6/30/1962
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Potatoes

John Noonan**	7/1/1949-6/30/1962
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Pathology

Dr. Leon S. Wood	4/4/1962-
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Irrigation

Paul D. Weeldreyer ^x	8/15/1978-
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Entomology

Dr. Ben H. Kantack 7/1/1963-
Dr. Wayne L. Berndt 12/1/1964-

Integrated Pest Management

Floyd F. Wiedmeier 6/16/1978-

*Located at Rapid City
**Located at Watertown
XLocated at Pierre

Extension Secretaries

The list of Extension personnel would not be complete if the secretaries were not included. They performed a variety of tasks to assist specialists. Secretaries were receptionists by telephone and for clientele (farmers, seedsmen, fertilizer dealers, chemical company representatives, state and federal employees and others). They typed letters, reports and manuscripts for publications; mimeographed and xeroxed reports; prepared visual aids; calculated yields from demonstration plots; left their desks to help run the state crop show; and many other tasks. The following incomplete list includes three secretaries who served the crops and weed specials (A) and two worked for the soils specialists (S) and were in separate offices. After July 1, 1960, they were in the same office. One was the head secretary* and the other an assistant.

Gertrude Van Maanen (A)	1/1/51-11/16/51
Alice Stern Lunden (A)	7/1/55-6/30/56
Carol Schlueter (S)	7/1/56-5/31/57
Loretta Tanberg (A)*	10/24/57-5/31/61
Jean Dobbs (S)	6/1/58-6/30-61
Marlys Cunningham*	6/1/61-3/31/61
Ruby Enevoldson	7/1/61-7/31/66
Sharon Rymerson-Diebert*	3/26/62-11/30/67
Marianne Gomez	9/1/66-2/13/70
Mary Lou St. Clair	12/1967-10-1969
Verna Mae Van Maanen*	1/19/70-
Marsha DeWitt	4/1/70-11/2/70
Rebecca Owens	11/2/70-7/24/72
Pamela Ponto Clark	8/1/72-10/15/76
Diane Reifschneider	10/18/76-8/31/77
Diane Buehre	9/1/77-7/15/81
Glenda Stewart	8/15/80-1/30-81
Shelly Schroll	7/28/80-2/27-81
Patricia Svenes	3/26/81-10/9/81
Peggy Bennett	5/18/81-

GROWTH AND DECLINE OF EXTENSION AGRONOMY

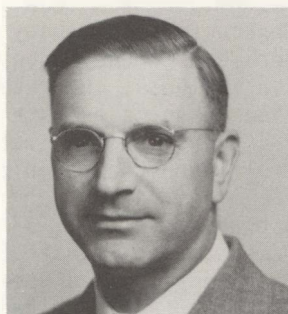
At first all Agronomy Extension programs were handled by one part-time person but as time passed and more technology was developed by research, more specialists were employed. As the number increased, titles changed and the degree of specialization also increased.

Expansion in Crops and Weeds

College catalogs list Manley Champlin as a researcher, instructor and parttime crops specialist in 1917-8 and crop and soil specialist in 1918-9 and 1919-20.

Ralph E. Johnston, a 1916 graduate of SDSC, became the first full-time Extension Agronomist on September 1, 1920. He was the link between research staff and farmers for such topics as crop production, variety selection, soils, fertilizer, plant diseases and weeds. During his 18-year tenure, he initiated several programs still being followed.

Rex Bankert became Johnston's assistant in 1937. Bankert had been responsible for the routine field work on the Agronomy Farm during the early 1930s. Both Johnston and Bankert resigned in 1938.



R.E. Johnston



U. J. Norgaard in 1940

U. J. Norgaard taught vocational agriculture at Salem during the 1920s and served as Sully County Agent for more than 12 years before becoming Extension Agronomist in 1939. Though reared in Wisconsin, he understood the agriculture of South Dakota and the people. He was Extension Agronomist for more than 19 years. Under his leadership many new programs were initiated.

Two Assistant Agronomists, Elmer E. Sanderson and Ralph A. Cline were added to the staff in 1945 and 1949 to expand programs in crop production, soil fertility, plant diseases, crop insects and weed control. Sanderson was previously Agronomy Farm Foreman for 7 years and county agent in Roberts County for 4 years. Cline had taught vocational agriculture and served as an SCS Research Project Supervisor in Montana before the SCS transferred him to SDSC in 1946. Though their titles changed twice, the length of service in the same position was almost 28 years for Sanderson and well over 22 for Cline.

Leonard L. Schrader, who had worked in the Seed Laboratory as an undergraduate and served as county agent in Sanborn and Davison counties, became the first Extension Weed Special-

ist on January 1, 1948. During the next 3 1/2 years he emphasized the organization of county weed boards and helped write the South Dakota Weed Manual.



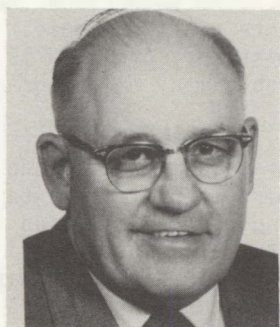
E.E. Sanderson



R.A. Cline

His successor, Lloyd R. Wilson, had been a vocational agriculture instructor and county agent in North Dakota, served as county agent in Spink County and was in business. He returned to the Extension Service to serve as Extension Weed Specialist for 2 years. He initiated the program of weed control demonstration plots.

When he left to go to graduate school, a recent M.S. graduate in weed control, Keith E. Wallace, became the third Extension Weed Specialist for a period of 7 years. Wallace had taught vocational agriculture and veterans agriculture before doing graduate work.



L. R. Wilson



K. E. Wallace

Expansion in Soils Extension

Shortly after the Soil Conservation Service was created, Ralph E. Hansen was employed as Extension Conservationist in 1937 to conduct educational programs pertaining to soil and water conservation. He concentrated on the organization of soil conservation districts. Almost half the districts in the state were organized when he left Extension in 1944.

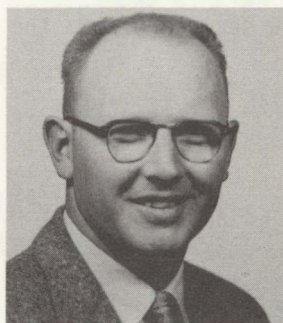


L. L. Ladd

Leonard L. Ladd left his position as County Agent at Huron to become Extension Soil Conservationist in 1945. During his 12-year tenure more than 20 soil conservation districts were organized and a soil fertility and management program initiated.

Raymond L. (Rosie) Venard, former county agent, returned from the service in the fall of 1945 to serve as Assistant Extension Soil Conservationist for a year before he became County Agent at Vermillion.

Merle E. Switzer, who had recently obtained an M.S. degree in soils at SDSC, was named Assistant Extension Soil Conservationist in 1951. R. Gene Gresham, who had just obtained an M.S. degree in soils, received the same title in 1955.



M. E. Switzer



R. G. Gresham

Joseph T. Paulson, a former SCS employee, became Watershed Flood Control Specialist late in 1954 and remained in that position for 7 1/2 years. When he retired in 1962, the position was discontinued.



E. J. Williamson

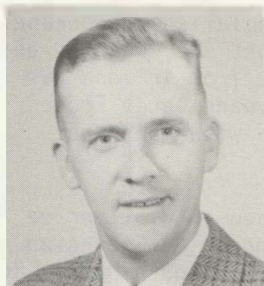


L. E. Davis

Ladd retired in 1956, Clarence Nelson was employed temporarily with special funds and Extension titles were changed. Switzer became Extension Soils Specialist and Gresham was Assistant Extension Soils Specialist. Both resigned in 1957.

Edward J. Williamson replaced Switzer, and Lloyd E. Davis replaced Gresham. Williamson had previously established the Soil Testing Laboratory and obtained an M.S. degree in soils. He accepted the position after returning from a soils assignment in Jordan.

Davis was another recent M.S. graduate in soils at SDSC.



R. Mesdag

Special funds were used to employ two more M.S. graduates as Assistant soils specialists for short periods in 1958 and 1959--Reinder Mesdag and Robert I. Papendick.

Reorganization

Norgaard retired as Extension Agronomist Emeritus in August, 1958. Acting Extension Director, W. E. Dittmer, delayed filling the position until a permanent director was appointed.

The need for a Ph.D. had been emphasized for research and teaching staff for several years; now it was recommended for state Extension staff. John T. Stone was appointed Director of Extension and was the first Ph.D. in the Extension Service. After several months he decided that Extension specialists involved with crops, soils and weeds should be in one group and asked Lyle A. Derscheid to be the leader of the group.

Derscheid had been project leader of the weed research project in the Agronomy Department for 14 years. He had never been an Extension employee, but was Extension oriented. He had been Wallace's major advisor and had officed with the Extension Weed Specialist for 8 years. His research was problem solving in nature and hundreds of research plots had been conducted in cooperation with county agents in over 20 counties. He had helped with the weed training of county agents, county weed supervisors and county weed board members. He was well acquainted with most of the Extension specialists, more than half of the county agents, and was well known to many of the leading farmers. In March 1960, he became the first Extension specialist with a Ph.D. degree.



L. A. Derscheid--1961

Derscheid still had charge of the weed project. His time was divided three ways--50% Extension Agronomist, 40% weed research and 10% teaching in the graduate school.

When he accepted the Extension appointment, Stone said: "You are in charge, whatever you say goes." Derscheid had the same philosophy. The area of responsibility of each specialist was clearly defined. Since each specialist was in charge of a certain subject matter area and was the authority on the subject, he was not considered an "assistant" or an "associate". Therefore, the titles were changed in 1962.

The title "Associate Agronomist" for both Sanderson and Cline was changed to "Extension Agronomist-Crops." Their areas of responsibility were not changed materially. Sanderson was responsible for production programs except for weed control, soil fertility and insects on spring grains, flax, corn, soybeans, and other crops raised in East River. He also took the lead on programs involving SDCIA, seed certification, foundation seed and 4-H. Cline was concerned with forage crops, winter grains, sorghum, range and other West River crops, as well as 4-H projects pertaining to range and programs involving range management organizations.

Williamson and Davis exchanged the titles "Extension Soils Specialist" and "Assistant Extension Soils Specialist" for the title "Extension Agronomist Soils." Williamson was in charge of the soil conservation, soil fertility for forage crops and grasslands, and the "Know Your Land" program. He was the Extension representative to the Conservation Commission, Association of Soil and Water District supervisors and to the SCS for the Great Plains Conservation Program. Davis was no longer an "assistant". He had charge of soils and soils fertility for all other crops and 4-H projects.

Extension Weed Specialist Wallace became Extension Agronomist-Weeds. He continued to have charge of weed control and proper use of herbicides programs.

Paulson's title and responsibilities did not change, but he did not become a member of the Extension Agronomy group. John Noonan was attached to the group for about a year before he retired. A former county agent in Codington County, he was named potato specialist in 1949 with an office in Watertown.

Noonan retired in 1962 and Leon Wood was employed as Extension Plant Pathologist in the Plant Pathology Department. A graduate of Ohio State, he had been a USDA plant disease researcher at SDSC during the mid-1950s. He obtained a Ph.D. and returned to relieve Sanderson and Cline of any plant disease responsibilities. A few years later, Wood took over the potato certification program.

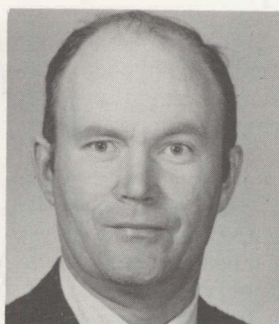
Derscheid worked half-time in Extension for 4 years. He served as the liaison between Extension and federal agencies--mostly SCS and ASCS. At first he spent considerable time as co-chairman with the SCS Agronomist writing agronomic sections of a technical guide to be used by all state and federal agencies. He assumed the responsibility for writing plans of work, annual reports and hiring staff, and he served as a backup for crops and weed specialists. He annually conducted a dozen or so tours of county crop variety demonstration plots, assisted with many weed training schools and served as Extension weed specialist for 5 months in 1961 and 7 months in 1966-1967.

He became full-time Extension Agronomist in 1964, and there were six full-time Extension Agronomists. Shortly afterwards he rejuvenated and expanded the pasture program--a more or less dormant activity that had been shared from time to time by Cline and Sanderson. In 1970 he also took charge of forage crop establishment, management and production.

Williamson resigned in 1962 to become Soil Conservationist with the Federal Extension Service in Washington, D.C. Edward L. Langin was employed. He had an M.S. degree from Nebraska and had been doing soil fertility research in the Agronomy Department. Since Davis was more familiar with the soil conservation program, he and Langin traded jobs--Davis took over Williamson's responsibilities and Langin took responsibility for soil fertility.



E. J. Langin



E. P. Adams

Davis left about a year later and was replaced by Earl P. Adams early in 1963. Adams had an M.S. degree from Minnesota and had been in the fertilizer division of Rath Packing Co.

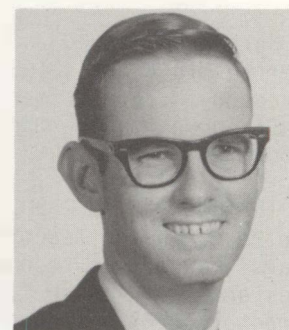
Langin left in June 1967 and Williamson returned from Washington, D.C. Williamson and Adams agreed to exchange areas of responsibility. Williamson resumed his former responsibilities and Adams took charge of soil fertility.

Wallace resigned in April 1961 to take a position as County Weed Specialist at Spokane, Washington. Kenneth R. Frost Jr., who had an M.S. degree in weed control from Arizona was employed that fall. Five years later Frost resigned to take a position with Monsanto Chemical Co.

Robert Parker III obtained an M.S. degree at Wyoming shortly before becoming Extension Agronomist-Weeds Specialist in South Dakota in June 1967. Two years later he resigned to enter graduate school at Utah State University.



K. R. Frost, Jr.

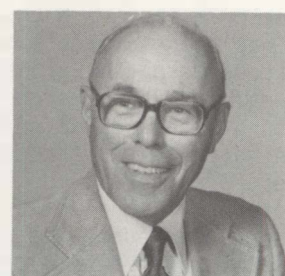


R. Parker III

Leon J. Wrage, who had obtained an M.S. degree in weed control under Derscheid's supervision and served as an Extension crops specialist in Wisconsin for 5 years, was appointed Extension Agronomist-Weeds in October, 1969.



L. J. Wrage



L. S. Wood

Leon S. Wood, Extension Plant Pathologist joined the crops, soils and weed specialists

in 1969 when Plant Pathology and Agronomy were merged into the Plant Science Department.

Decline in Extension Agronomy

The Extension leader in each discipline was responsible to the Director of Extension for administration and to the Department Head for subject matter. During the late 1960s the Dean of Agriculture began to urge the director to mandate that specialists be responsible to the respective department heads for administration also. The Director resisted the idea. Department Heads were trained in research and had experience in research and teaching, but few had an understanding of or interest in Extension. It would only be natural for them to favor research when choices had to be made between research and Extension.

Director Stone resigned in November 1971 and Dean Acker assumed the directorship. The next spring Extension specialists salaries were determined by the department heads.

In 1972 a budget was submitted for a research agronomist to be located at the newly established West River Research and Extension Center in Rapid City. Robert Hoeft, who had recently obtained a Ph.D. degree in soils from Illinois, was employed with money obtained from a grant. The funds requested for the new position were not obtained.

Ralph Cline retired in June 1972. Most of his work was done in West River. Hoeft was already living in Rapid City and there was little money for a research position at that location. Hoeft was hired as Extension Agronomist-West River on a split appointment--80% Extension and 20% research. A soils man was employed to conduct an Extension program in crops. In order to maintain the same number of full time equivalents (FTE) on Extension funds and continue the research started with grant money, Experiment Station funds were traded for Extension money. Portions (10% for each) of the salaries of the Head of Agronomy and the Manager of the Southeast Experiment Farm near Centerville, normally paid from Experiment Station funds, were paid from Extension, leaving research funds for use at Rapid City.

Hoeft, a soils man, was not well suited to conduct educational programs on winter crops and sorghum production and range management; he much preferred soil fertility work and returned to Illinois where he obtained a position in that field.



R. Hoeft



J. R. Johnson

James R. Johnson, who had majored in Agronomy and been on the staff at the Newell Irrigation Station for a few years, had recently obtained a Ph.D. degree in range management at Oregon. He became the crops-range specialist at Rapid City in 1974 with an 80-20% split between Extension and research. He was the first Extension specialist with a range background and training, and he devoted about half his Extension time to range improvement and management for about 4 years. He left the position to become a full-time range specialist at Rapid City in the Animal Science Department.

When Johnson left, the Extension responsibilities of the position changed. They still included crops grown in West River, but weed responsibilities replaced those for range. Clair E. Stymiest had worked on the weed research project as an undergraduate, had been Assistant in Agronomy while obtaining an M.S. degree in weed control and had taught junior college courses in Minnesota for 7 or 8 years. He went to Rapid City to assume the duties of Extension Agronomist-West River.

Sanderson took an early retirement in 1973. Once again Extension funds were used to supplement the departmental budget. The Department Head decided to partially alleviate his tight budget by paying 70% of J. Duane Colburn's salary and 30% of Robert Pylman's salary from Extension funds. Colburn had been Manager of the Seed Certification Service for about 15 years, and Pylman was the spring wheat breeder. Both retained these responsibilities which were full-time jobs, leaving little time for Extension activities. Colburn had been a vocational agriculture teacher and been on the program at numerous SDCIA district meetings and Pylman's father had been a county agent for many years, but neither had actual experience or interest in Extension.

After 2 years Colburn and Pylman returned full-time to their previous positions and Donald J. Reid was appointed Extension Ag-

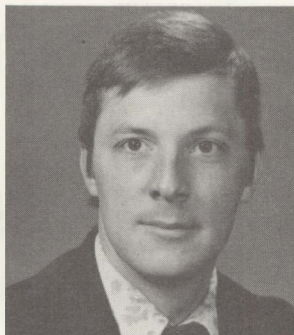
ronomist-Crops. Reid had obtained a Ph.D. in forage crops at Cornell University and had been Area Agronomist for 9 years in the Upper Peninsula of Michigan. Though given the opportunity to be the forage crop specialist, he chose to assume the responsibilities formerly held by Sanderson and then Colburn and Pylman.

During the mid-1970s Adams suffered a heart attack and recovered. As interest in energy conservation mounted, he became more active in the area than his health would allow. He suffered a fatal attack on June 22, 1978 in the Sioux Falls airport while enroute home with agricultural engineering specialists from Rapid City.

Because of a shortage of funds, the position could not be filled until January 15, 1979. Robert P. Schoper of Minnesota with an M.S. degree in soils and a year's experience as an Extension soils specialist, was employed. He spent slightly less than 2 years in the position.



D. J. Reid



R. P. Schoper

Williamson and Derscheid took early retirement in 1979. The Extension Service suffered a budget reduction resulting in a loss of 0.8 FTE in Agronomy Extension. Several months passed before either vacancy was filled. Late in 1980 James R. Gerwing, another Minnesotan with an M.S. degree in soils and experience as Area Agronomist, was employed. He worked closely with Schoper for 2 months and assumed the responsibility for soil fertility when Schoper resigned.

It was suggested that a recent graduate, who had been an SCS employee for several years before returning to SDSU to obtain an advanced degree in forage crops, be employed as an Extension agronomist. He would conduct Extension programs in soil conservation, forage crops and pastures--work formerly done by Williamson and Derscheid. This suggestion was not accepted.

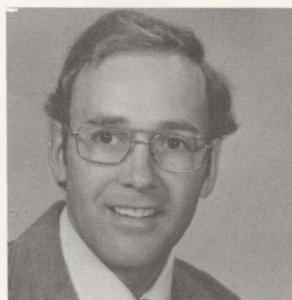
About the same time J. G. Ross, SDSU forage crop breeder retired and there was discussion

about the hiring of a forage specialist on a split appointment--60% Extension and 40% research. He would replace Derscheid as part-time Extension forage crop specialist and partially replace Ross with the forage crop research. No action was taken.

About the same time, a budget reduction caused the Institute of Water Resources to discontinue one position. The Head of Plant Science decided to use funds from the positions left vacant by Ross and Derscheid and/or Williamson to employ the individual on a split appointment--40% Extension and 60% research even though the individual had no expertise in soil conservation, forage crops or pastures--areas in which clientele were seeking information weekly. It was decided that the new specialist would do modular programming. It was the third time in less than a decade that Extension funds had been used to augment short budgets in other areas.

In August 1981, Reid accepted a teaching position in his home state of Texas. Before the position was filled, a reduction in federal funds on October 1 caused the Extension Director to "freeze" all vacant positions.

There were two full-time and one-part time (80%) agronomy specialists to conduct the programs that had been handled by six full-time specialists from 1964 to 1972. The program in soil conservation, pasture management and improvement, forage crop fertility; production programs for forage crops, corn, soybeans, spring grains, flax and sunflowers; and liaison programs with SDCIA, SCS, ASCS and Seed Trade were sharply curtailed at least temporarily



J. R. Gerwing



P. D. Weeldreyer

New Additions

Farmer groups persuaded the legislature to appropriate \$15,000 for an Area Extension Irrigation Specialist to be located at Pierre. The Department Head tried unsuccessfully to fill the position for several months. He left the state in June 1978. Paul D. Weeldreyer was Assistant in Agronomy working toward an M.S. degree in soils and irrigation. Soon

after the Department Head left, the Extension Agronomist recommended Weeldreyer for the area specialist position. He started work on August 15.



W. L. Berndt



B. H. Kantack

On July 1, 1979, when Entomologists were transferred to the Plant Science Department, Extension Entomologists Benjamin H. Kantack and Wayne L. Berndt and Integrated Pest Management Specialist Floyd Wiedmeier joined the group of crops, soils, weed and pathology specialists. Kantack, a Nebraskan, had a Ph.D. from Kansas and had been on the SDSC research staff for a year before becoming Extension Entomologist in 1963. Berndt, an SDSC graduate with a Ph.D. from Kansas, was appointed Extension Pesticide Specialist in 1964. Wiedmeier, a former Assistant County Agent at Rapid City and County Agent at Martin and Hot Springs, became Integrated Pest Management Specialist in 1978.

L. J. Wrage was offered the position of Extension Agronomist when Derscheid retired. The administrative duties would require at least one-fourth of his time and he was reluctant to relinquish that much of his weed responsibilities. The Department Head took the Extension project leader responsibilities, but Wrage supervised the Extension office and coordinated the preparation of reports such as annual reports, plans of work and others. Wrage retained the title of Extension Agronomist-Weeds.

ORGANIZATIONAL ACTIVITIES

Organizations and Extension go hand in hand. Extension had the responsibility of conducting educational programs for state and federal agencies. Consequently, Extension agronomists became closely allied with the Soil Conservation Service (SCS) the State Weed Board and the Agricultural Adjustment Administration (AAA) which became the Agricultural Conservation and Stabilization Service (ASCS). They had frequent associations with the Bureau of Reclamation (BOR), Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM) and others.

Some educational programs were conducted for the purpose of developing county organizations that had specific objectives. Extension Agronomists organized 58 county crop improvement associations and played major roles in the organization of 71 soil conservation districts, 63 county weed boards and several watershed projects.

Crop Improvement Association

On September 18, 1906 a group of corn producers sponsored a corn show and school. The school was conducted by John S. Cole and A. N. Hume of Illinois. Cole also gave an address "Advantages of Corn in the Crop Rotation." During the meeting, the South Dakota Corn Growers and Corn Breeders Association was formed (JW-2). Cole conducted the school and discussed the work of Experiment Stations at the 1907 meeting of the group (JW-5).

The name of the organization was changed in 1909 and Clifford Willis was elected as secretary to the South Dakota Corn Growers and Grain Growers Association in 1909 or 1910 (JW-6). He resigned in November, 1911 (JW-7), and was the first of eight agronomists to serve in that capacity.

As in most organizations, the secretary played a vital role in developing programs for the membership.

A. N. Hume, Head of Agronomy, served as secretary from 1912 (JW-7) until 1924 (JW-22) or later.

The South Dakota Experimental Association was formed in 1912. Its purpose was to bind together graduates of SDSC and the School of Agriculture in an effort to assist the college in testing new crops and varieties. The membership was closely correlated with that of the South Dakota Corn and Grain Growers Association (JW-21). Manley Champlin was the secretary (JW-22). Ralph E. Johnston became Extension Agronomist at about the same time that Champlin left the Agronomy Department and succeeded Champlin as secretary (JW-21).

The South Dakota Corn and Grain Growers Association and the South Dakota Experimental Association merged in 1925 to form the South Dakota Crop Improvement Association (JW-23). Hume was the secretary (JW-22) and Johnston the assistant secretary (JW-29). During the same year, the Extension Service and SDCIA entered into an agreement to establish a certified seed production program under the supervision of Johnston (JW-29).

Because of a mutual interest in the production and use of Certified seed, crop improvement members began producing Certified seed of

small grains and flax. A program to produce Registered seed of alfalfa and clovers was developed by Johnston, and crop improvers began to produce the seed in 1929. Also in 1929 Johnston began to plant variety demonstration and variety performance tests on the farms of crop improvement members.

By that time Johnston had become secretary of the SDCIA. After he left the Extension Service in 1938, his assistant, Rex Bankert, served as secretary. Six months later Bankert resigned from Extension and U. J. Norgaard, the newly appointed Extension Agronomist, was elected to the post.

Norgaard believed that best results were obtained by working with organized groups of informed persons. He used his position as secretary to the SDCIA to organize county crop improvement associations for that purpose.

County crop improvement associations were involved in increasing seed of new varieties, production of Certified seed and conducting variety and fertilizer demonstrations. Twenty county crop improvement associations were organized in 1939. There were 41 associations in 1945, 47 in 1947 and 58 in 1950. Because the associations from two or more counties merged in some areas, the number dropped to 55 in 1979 and 54 in 1980 with 2,331 members.

Several meetings involving Norgaard, W. W. Worzella, Head of Agronomy, and various SDCIA committees were held. They led to the organization of the Foundation Seed Stock Division, the legalization of the Seed Certification Service, the memoranda of understanding between these organizations and others concerned with seed distribution and quality and the development of new state seed and weed laws.

Elmer E. Sanderson edited the Crop Reporter for about a decade. The first issue came out in 1946. The purpose of the publication was to inform crop people about the work of their Experiment Station and the Seed Certification Service and to supply them with the latest information on crop improvement. The Crop Improvement Reporter continued until 1955 when it was dropped due to lack of finances (Ext 24).

Norgaard retired from the Extension Service in 1958. As an Emeritus, he was paid about \$1,600 a year--the amount that Social Security retirees were allowed to earn. Such retirees were expected to work about one-fourth time. To meet this requirement Norgaard continued as secretary of SDCIA. Extension Agronomy continued to store SDCIA records and provide stenographic and other assistance. In 1964 after serving as secretary for a quarter of a century, Norgaard asked to be relieved of the responsibilities.

Lyle Derscheid, Norgaard's successor as Extension Agronomist, had only been an Extension specialist for 4 years. He asked not to be nominated for the secretaryship and suggested that the position of secretary-treasurer be divided between Elmer Sanderson and Ralph Cline.

Both had assisted Norgaard for several years, had worked closely with the SDCIA board and had organized county associations. Sanderson was elected secretary and Cline as Treasurer. Both continued to work closely with the Seed Certification Service and Foundation Seed Stock Division, and Sanderson continued to update and revise memoranda of agreements for the organizations.

Cline retired in 1972. Derscheid suggested that the function of Extension was to develop an organization and when mature the organization should handle its own business. Fred Holscher, SDCIA president, said: "Without Extension the SDCIA will die." As a compromise J. Duane Colburn who for 12 years had been Manager of Seed Certification Service a division of SDCIA, and had been handling money for the association, was elected treasurer.

Sanderson retired in 1973 and Colburn was appointed part-time Extension Agronomist. He was elected secretary-treasurer. Two years later he returned full-time with the Seed Certification Service and retained the office in the SDCIA. He left the Seed Certification Service in 1978. His successor, Robert J. Pollmann, was elected secretary-treasurer of the SDCIA at the annual meeting in June.

Crop Shows

The organization started in 1906 with a corn show. However, the name of the organization was changed in 1909 so that seeds of small grains, grasses and legumes would be included (JW-6). Sorghums were included in the show in 1915 (JW-10). Johnston judged the show in 1921 (JW-15). From that date on it seems that Extension agronomists played an important role in SDCIA sponsored crop shows. Records of the crop shows were not reviewed thoroughly, but it is probable that a show was held in conjunction with the annual meeting almost every year until 1979 when the show was discontinued, at least temporarily.

Starting in the 1950s and perhaps earlier, Extension agronomists organized and supervised the show. They encouraged county crop improvement associations to put up booths and to bring samples from county and district shows. Extension agronomists prepared premium lists, publicized the show, secured judges, supervised the setting up of the show, entered samples, supervised the determination of test

weights and supervised the judging and the attachment of ribbons on winning samples. County crop improvement members and other local people generally provided space and helped set up the show, take test weights, attach ribbons and dismantle the show. For at least 2 decades members of the Agronomy Department--a dozen or more--judged the classes of seed or forage with which they were most familiar. When the show was held at Brookings, the Agronomy Farm crew and other technicians frequently provided the assistance given by local personnel. In 1974 state employees spent over 75 man-days on the last show held in Brookings. While this included the time spent on the crop show, annual meeting of SDCIA, and the State Weed and Pest conference, more than half of the effort went into the crop show.

By 1960 it was apparent that the State Crop Show no longer fulfilled its original objective of providing a place for seed producers to display their wares and seed buyers to locate seed they wanted to purchase. By the mid-1950s corn producers were planting hybrid corn and did not buy seed from commercial corn producers. Also grand champion seed samples of small grains, forages, etc. were only 1 gallon or less of seed that had been hand picked from much larger samples. They represented the showmen's showmanship--not the quality of the lot or the productivity or adaptability of the variety.

At an SDCIA board meeting, Derscheid suggested that the crop show be replaced with a Certified seed show in which 1-bushel samples, representing the lot of seed for sale, would be shown. The suggestion fell on deaf ears. However, when Don Jorgensen of Ideal was SDCIA president, he promoted the idea. In 1971 a Certified seed show was held in conjunction with the state crop show. Duane Colburn, Manager of Certified Seed Service, supervised the show and R. C. Kinch, Director of Seed Testing Laboratory, judged it. It was part of the crop show until 1979.

When the SDCIA board was urged to discontinue the crop show in 1979, it was suggested that the Certified seed show be continued. Some members wished to follow the suggestion, but a majority voted to discontinue both shows for at least one year. The association continued to have its annual meetings in March, but so far has not revived the crop show.

District Meetings

The state was divided into eight crop improvement districts. Each year county crop improvement members and county agents from counties within the district had an annual meeting. Every third year a member of the

group, usually the chairman, was elected to the SDCIA board for a 3-year term. At the annual meeting in 1964, the SDCIA voted to limit these representatives to two terms in order to get "new blood" on the state board periodically.

The SDCIA secretary arranged the meetings, prepared the programs and one or more Extension agronomist appeared on the program along with the managers of the Seed Certification Service and Foundation Seed Stock Division.

State Fair Exhibit

Starting in 1948 the SDCIA sponsored a booth at the State Fair in the Agricultural Building. All arrangements were made by the secretary. Extension agronomists manned the booth. For about 15 years a different aspect of crop production and soil fertility and management was featured. Sheaths of new small grain varieties always attracted attention. Starting in the early 1960s a Certified seed show was held in conjunction with the booth. A few years later the Agricultural Building was destroyed by fire. The booth may have been discontinued for a year or so until the Expo Building was completed in 1971. For the next decade the 24-foot booth featured sheaths of new small grain varieties and the Certified seed show. The SDCIA secretary was in charge of the exhibit, but it was a cooperative effort between Extension agronomists and the managers of the Seed Certification and the Foundation Seeds Stock Division--they erected the display and took turns attending the booth. SDCIA board members each spent a day at the booth during the State Fair.

Other Programs

Extension agronomists played a major role in the distribution of Foundation seed of over 250 varieties to SDCIA members and assisted the SDCIA with its projects. Many of these projects resulted in improved research facilities and buildings and the addition of plant breeding projects in the Experiment Station. However, no records were located to indicate that the SDCIA ever attempted to assist the Extension Service.

Conservation Organizations

In 1937 the State Legislature passed a law which established a State Soil Conservation Committee (LL-7), outlined the procedure for setting up soil conservation districts and specified the duties of district supervisors (LL-9).

The law became effective July 1 and Ralph E. Hanson was employed in October as Extension Conservationist. At first his major task was

to conduct educational meetings aimed at the organization of soil conservation districts.

Two districts were organized in 1937, three in 1938, two in 1939, five in 1940 and a dozen in 1941 (LL-11).

In February 1941, a 2-day meeting was held in Mitchell. At least one supervisor from each of the first 12 soil conservation districts met with the Extension Conservationist, a state committeeman for AAA (now ASCS), an SCS representative and others to plan projects and practices and to develop a program whereby all agencies could assist with the establishment of conservation practices on the land (LL-13).

During the evening, the district supervisors met separately and decided to meet in Pierre in February 1942 with all the supervisors of all the districts to form an association of district supervisors (LL-13).

By the end of 1941 there were 24 soil and water conservation districts. Supervisors from these districts met in Pierre on February 9 and 10, 1942 and organized the South Dakota Association of Soil and Water Conservation District Supervisors. Hansen, Extension Conservationist, became the first of seven Extension specialists to serve as secretary (LL-14).

By the time Hansen resigned in 1944, 32 soil conservation districts had been formed (LL-12). Leonard L. Ladd became Extension Soil Conservationist.

In 1945 a total of 1,981,177 acres were organized into districts--320,917 into a new district and over 1 1/2 million acres added to eight existing districts. A total of 14,890,909 acres, 30% of the cropland and 40% of the state, were included in soil conservation districts.

The SDASWCDS did not meet in 1945. Ladd was elected secretary in 1946 and held the position for 5 years. Merle E. Switzer, Assistant Extension Soil Conservationist, served as secretary from 1952 to 1955 (LL-12).

By the end of 1955 there were 66 soil and water conservation districts in the state covering an area of 36,030,373 acres. The area included all of 59 counties and part of another. Unorganized counties included Douglas, Edmunds, Faulk, Walworth and part of Lyman.

When Ladd retired in 1956 there were 69 soil and water conservation districts in existence (LL-11). Switzer resigned in 1957. Edward J. Williamson became Extension Soils

Specialist and served as secretary in 1957 and from 1959 to 1961.

Reinder Mesdag, Assistant Extension Soils Specialist, was secretary in 1958. He resigned and was replaced by Lloyd E. Davis who served as secretary in 1959 and 1962.

Records do not indicate how Hansen and Ladd were associated with the Conservation Commission, the state organization in charge of conservation programs. Williamson, however, met with the Commission on a regular basis. The Director of Extension was a member of the group and Williamson served as a consultant and advisor.

By 1959 all of the state except Douglas, Faulk, Hutchinson and east Corson counties were organized into soil conservation districts. There had been some consolidation of districts along county lines, but more than 90% of all farmland in South Dakota was organized into 65 districts. Hutchinson was organized in 1961 and Douglas in 1965. A total of 71 districts had been organized, but the area was now included in 67 districts.

Earl A. Adams became Extension Agronomist-Soils in 1963 and served as secretary to the SDSCWDS until 1967. At the Rapid City meeting, John T. Stone, Director of Extension, addressed the group. Among other things, he mentioned that Extension specialists had served as secretary for 25 years and that the organization should be mature enough to provide its own secretary. He, however, volunteered the services of Extension Agronomy for reproducing and distributing copies of the minutes and other similar documents. The organization elected a secretary from its membership for 1968 and subsequent years.

Williamson and Derscheid continued to attend SDSCDS annual meetings and serve on committees and Williamson continued to meet with the Conservation Commission until 1979 when both specialists retired.

Weed Organizations

A new weed law, sponsored by the SDCIA, was passed by the 1945 Legislature. It named members (by virtue of their positions) to the 9-member State Weed Board. The Director of Extension, Head of the Agronomy Department and Secretary of Agriculture were members because Extension was responsible for educational programs, Agronomy for research and the Department of Agriculture for law enforcement. The state weed law authorized the hiring of a State Weed Supervisor and the establishment of County Weed Boards to conduct weed control programs in the various counties.

The first appropriation was made in 1947. Elmer Sanderson was appointed, temporarily, as State Weed Supervisor in March. When the position was filled permanently by William Klatt, Sanderson returned to his duties as Assistant Extension Agronomist. The appropriation included \$10,000 for an Extension weed specialist. Sanderson added those duties to his own for the remainder of the year.

The specialist and county agents conducted 170 weed meetings in 1947 (Ext-25). Most meetings were held for the purpose of organization. Meetings were held in each ASCS district of most counties. The losses caused by weeds were emphasized. The state weed law was explained; and methods of control with cultivation, competitive crops and 2,4-D were discussed. Land owners were then given the opportunity to vote on whether they wanted an organized weed program in the county which would permit the county commissioners to levy a tax of one mill on the assessed valuation of all real and personal property to finance the program.

Leonard L. Schrader became the first Extension Weed Specialist on January 1, 1948.

Norgaard met regularly with the SWB for several years, and was active in the formulation of rules, regulations and policies that the board still follows. Funds for Extension, research and law enforcement were appropriated to the SWB and then reallocated to the Extension Service, Agronomy Department and Department of Agriculture. As a consequence Extension weed specialists--Schrader (1948-1951), Lloyd R. Wilson (1952-1954), Keith E. Wallace (1954-1957), weed researcher Lyle A. Derscheid and a representative of the Department of Agriculture were expected to give annual reports to the SWB at its annual meeting in June or July.

Other members of the SWB included the presidents of SDCIA, SDSCWDS, S.D. Horticultural Society and three members of state government who controlled state owned land--Commissioner of School and Public Lands and a member from each of the Game, Fish and Parks Commission and State Highway Commission. The president of the S.D. County Commissioners Association was added later because county commissioners held the purse strings in the counties.

Reorganization of Weed Board

Charles Brett of Hanson County was Secretary of Agriculture during the mid-1950s. He believed that Charles J. Gilbert, State Weed Supervisor, should report to him, and was sometimes irritated when Gilbert indicated that the law was not being enforced properly.

In 1957 Brett was elected to the legislature. He sponsored a bill to amend the State Weed Law. When enacted into law, the State Weed Board became the State Weed Commission, a division of the Department of Agriculture. At the same legislative session, the directors of Extension and Experiment Station included budgets for education and research in their respective budgets. Membership on the board was changed and there was no appropriation for the SWC. The State Weed Supervisor and two assistants were out of a job on June 30.

The Secretary of Agriculture, Director of Extension, Commissioner of School and Public Lands and one member each from the State Highway Commission, Game, Fish and Parks Commission and County Commissioners Association retained membership on the new commission. However, the presidents of SDCIA, SDASWDS and South Dakota Horticulture Society were replaced by three farmers appointed by the Governor from a list of nominees submitted by the State Association of County Weed Boards. The Head of Agronomy was replaced by the Dean of Agriculture or his appointed representative. The Head of Agronomy was the appointed representative until 1973. When Raymond A. Moore was promoted from Head of Agronomy to Director of Experiment Station, he retained membership on the commission.

Wallace and successors Kenneth R. Frost, Robert Parker III and Leon J. Wrage continued to meet with the SWC. Derscheid also served as a consultant, first as a weed researcher and then as Extension Agronomist, until the mid-1970s.

Herbert Hokanson, Roberts County Weed Supervisor, served as a part-time State Weed Supervisor from 1957 until 1959 or 1961 when funds were appropriated for a full-time supervisor. Benjamin Nelson, Ellsworth Lien and Raymond Eilers served successively as State Weed Supervisor and Head of the Weed Division in the Department of Agriculture. They reported to the Secretary of Agriculture. It was a unique situation. Though the SWC adopted policies and programs, one member (the Secretary of Agriculture) could nullify any activity requiring the services of the supervisor.

Weed Conference and Fair Booth

The SWB started to sponsor a booth at the State Fair and the State Weed and Pest Conference in 1948. At least 1200 attended the 1949 conference held at SDSC and over 1000 were at Aberdeen in 1950. Though the State Weed Supervisor was general chairman for both activities, the Extension Weed Specialist spent several days each year in the State Fair exhibit and arranged the program for the Weed and Pest Conference.

The State Weed and Pest Conference was financed originally from an appropriation for that purpose and fees charged to chemical and sprayer companies for exhibit space. After 1957 the Secretary of Agriculture did not include money for the conference in the SWC budget. During the late 1960s commercial exhibitors began to lose interest and income from fees declined.

During 1958, 1959 and perhaps a couple more years when there was no full-time supervisor, Keith Wallace, Extension Weed Specialist, took charge of the State Fair exhibit and State Weed and Pest Conference. County weed supervisors assisted at the fair and Derscheid and the Extension entomologist assisted with the conference.

After Kenneth R. Frost became Extension Weed Specialist in 1961, he and the State Weed Supervisor were co-chairmen for both events--the supervisor had charge of exhibits and Frost the program.

Shortly after Derscheid became Extension Agronomist in 1960, he decided that better use of specialists and county agents time would be obtained and perhaps larger crowds would be attracted if the State Crop Show and State Weed Conference were held in one 2-day meeting instead of two 1 1/2-day meetings. On several occasions he voiced this opinion at SWC and SDCIA board meetings.

Both groups agreed in 1968. Except for 1970, when the Weed and Pest Conference met with the North Central Weed Control Conference in Sioux Falls during December 1969, the annual meeting of the SDCIA and the State Weed and Pest Conference were held at the same time and location. After the first meeting, several weed workers expressed displeasure at having the two programs integrated. For several years the weed program was held one day and the crop improvement meeting on another. Since attendance was generally lower on the second day, the two programs were alternated annually. In 1976 the programs were integrated again. During that period Derscheid was general chairman and other Extension specialists took charge of the programs, crop show, banquets and other arrangements.

Association of County Weed Boards

The state was divided into nine weed districts. Each fall members of county weed boards, county weed supervisors and county agents from counties within each district held a meeting. Meetings were organized by the state weed supervisor and Extension weed specialist. Both appeared on the program with representatives of other groups concerned with noxious weed control such as railroads, highways and parks. Each county gave a report.

The chairman of each district, a county weed board member, was a member of the board of the Association of County Weed Boards. Each county board paid dues to the state association.

The association held an annual meeting at the State Weed and Pest Conference, nominated farmers to serve on the State Weed Commission and after 1957 frequently provided funds to finance the State Weed and Pest conference.

The board members met annually at the State Fair with the Extension weed specialist and state weed supervisor to plan the program for district meetings and to discuss other weed topics.

South Dakota Seed Trade Association

South Dakota formed a South Dakota Seeds-men's Association, perhaps during the 1930s. Seed analysts from the State Seed Laboratory--E. L. Erickson from 1939 to 1947, R. C. Kinch from 1947 to 1975 and A. O. Lunden after 1975 met regularly with the group. The Extension Agronomist met with the group periodically during the 1950s and regularly during the 1960s and 1970s. The Manager of Seed Certification Service also met with the group annually during the late 1950s and the 1960s and 1970s.

Norgaard met with members of the organization for the purpose of developing memoranda of agreement with the Experiment Station, SDCIA and Foundation Seed Stock Division for the release of foundation seed.

The group asked for a 1-day shortcourse to be held in Brookings. The first one was held in January 1968. Each year Derscheid met with a seedsman's short-course committee early in October. The group determined the topics to be discussed at the January shortcourse. Derscheid secured speakers, arranged the program and compiled a proceedings that was distributed at the shortcourse.

The organization frequently cooperated with the SDCIA when sponsoring legislation to approve or expand research facilities in Agronomy.

EXTENSION CROPS PROGRAMS 1920-1960

During the 1920s, Johnston was responsible for all programs pertaining to Agronomy. He prepared many mimeographed publications which were the forerunners of Extension leaflets, circulars and fact sheets. He also adopted the practice of working with organized groups when he became active in the Corn and Grain Growers Association. His topic on the 1924

program was: "A Car of Rock Phosphate in South Dakota." (JW-19). Perhaps he discussed results obtained from an experiment conducted by J. G. Hutton. Hume, Hutton and E. S. McFadden were also on the program (JW-19).

In 1925 Johnson, Hume and W. F. Kumlien, Director of Extension, drew up a plan for doing seed certification work. The plan specified that "the Extension Agronomist will adopt seed certification as one of his sub-projects for the year . . . The Crop Improvement Association will pay 75% of all certification fees collected to the Extension Service toward the expenses of the Extension Agronomist." R. E. Johnston was to direct seed certification and registration as assistant-secretary of the association (JW-29).

In 1930 Johnston wrote: "There has been a definite turn to the conducting of Agronomy Extension work through county committees . . . resulting in better organized, very sound, more complete, efficient and larger volume of crops, weed and soils work."

He delineated seven projects: (1) corn, (2) crop variety demonstrations, (3) developing supplies of quality seed, (4) smuts on small grain, (5) fertilizer demonstrations, (6) weed demonstrations and (7) wheat surveys. Several projects included two or more sub-projects.

Sub-projects for corn included 10-acre contests and seed selection demonstrations. The 10-acre demonstrations were conducted on 75 farms in 1931 to develop and show the best methods of producing corn. Seed selection demonstrations were held in 20 counties to emphasize the use of proper-type ears and kernels from superior plants to improve corn production.

Demonstrations with phosphorus fertilizer, mostly on corn, were started in 1926. The next year small grain variety demonstrations were planted, and in 1930 corn variety demonstrations were conducted.

In 1931, leaflets, circulars, letter inserts, charts, film strips, news articles and demonstrations were used in the spring wheat growing area to emphasize the small grain losses caused by smut, especially covered smut in wheat.

Sub-projects pertaining to seed were: (1) providing a supply of good quality seed, (2) Certified seed for small grain and flax, and (3) Registered seed for alfalfa.

Since good quality seed was essential to the production of good products, the aim of this program was to make high quality seed of adapted varieties available to all crop producers.

The programs for the production of Registered seed of alfalfa, initiated in 1929, placed emphasis on the need to produce Registered seed of Cossack and Grimm alfalfa to meet competition from western states.

Reports from Spink and Sully counties showed Certified and/or Registered seed had been produced by seven farmers in Sully and three in Spink during 1930. A total of 1,025 acres in Spink were inspected for certification in 1931. Varieties included Ceres, Marquis and Hope spring wheat, Mindum and Kubanka durum, Velvet barley, Bison flax and Cossack and Grimm alfalfa.

Wheat surveys were conducted in most of the wheat producing counties that had county agents in order to secure facts and demonstrate the situation with respect to wheat quality for wheat standardization work.

Miscellaneous types of work in 1931 included assistance with six community crop shows, a district crop show at Aberdeen, a state seed show at Aberdeen, the state crop show at Sioux Falls, "make-up" of seed lists, revision of rules for grain and flax certification and alfalfa registration and participation on the Farm and Home Program at SDSC. Johnston assisted the Soo Line Railway with a crop exhibit at Veblen and the "M & St. L." Railway with a pure seed and seed treatment conference at Conde. He conducted crop tours in Marshall and Codington counties, attended the Western Regional Meeting and the International Crop Improvement Association Meeting held in Salt Lake City and was appointed by the Governor to the State Seed Committee that elected him secretary.

Under Norgaard's leadership during the next two decades, several concepts initiated by Johnston were continued--working with organized groups, production of high quality seed, variety demonstrations, fertilizer demonstrations, weed control, disease control and the use of a legume in a crop rotation. The idea of farming around natural hazards to reduce the risk of crop failure and the use of large exhibits were added. Though the activities initiated by Johnston were continued, the working of annual reports was altered considerably during the 1940s and 1950s.

During the early 1940s, South Dakota was described as the transition agricultural area of three great agricultural regions--ranching, wheat and mixed farming, and corn and mixed farming.

During the late 1940s and the 1950s South Dakota was a "pivot state" of three great agricultural regions--ranching, wheat, and mixed farming.

This fact had fundamental and sometimes tragic consequences because of the land use problems involved.

If these areas were well defined and would "stay put" like they appeared on land use charts and maps, the problems would not have been so great. But as seasons came and went these so-called areas moved back and forth. The types of agriculture and practices were developed, which in the long run caused maladjustments and distress.

The tendency was for agriculture to swing too far in certain directions with the weather cycle.

South Dakota like the rest of the states had definitely developed her agriculture on the philosophy of exploitation of natural resources with the inevitable regrettable consequences.

The program of exploitation had been undertaken by the people, deliberately or otherwise, in spite of the teachings and warnings of agronomy workers. Leaders in crops and soils always taught proper land use and conservation.

Consequently, the problems connected with Agronomy were deep seated since they concerned problems regarding land patterns, water erosion, wind erosion, weed infestation, land use, markets and national economy.

False conceptions, or rather a disregard for long range climatic and biological (insect) hazards contributed much to the plight of agriculture and, during the early 1940s, directed the agricultural program, including Agronomy, toward conservation projects.

During the early 1940s the crops program was outlined as follows:

1. Small grain improvement--variety demonstrations, phosphorus yield tests, seed schools.
2. Corn and sorghum improvement--variety yield tests, development of hybrid corn organization.
3. Legumes--cooperate with AAA to promote soil building crops.
4. Grass--cooperate with SCS on grass species demonstrations.
5. Pastures--cooperate with dairy and Greater South Dakota Assn. on 80 pasture contests in eight counties.
6. Special crops--soybean variety demonstrations, promote certified seed potatoes.

7. Weed control--work with SDCIA to develop new weed and seed laws, weed control demonstrations and bindweed tour.

8. Cropping to avoid hazards--discussions at 14 meetings in 12 counties and tillage demonstrations.

Starting in the mid-1940s it was stated that economic and social conditions as well as improper land use, drought, grasshoppers, soil erosion and weeds were important factors.

All of these factors, except drought, it was felt were controllable. Even the effects of drought could be softened by proper land use and moisture conservation practices.

To meet these acute problems, many government agencies had been created--Agricultural Adjustment Administration (AAA), Farm Security Administration, Farm Credit Administration and Soil Conservation Service (SCS). There was a great need for more coordination between all the public agencies so that each group could do more efficient work in its respective field.

A disregard for long range climatic and biological hazards contributed much to the crop failures. Many times farmers suffered severe losses from the so-called "natural" hazards of drought, heat and grasshoppers.

The tendency to introduce unadapted crops and varieties and cultural practices into an area during abnormal wet seasons was particularly hazardous and one of the biggest problems, because when drier conditions came these crops and varieties failed.

Therefore, it became the goal of Extension Agronomy to devote every effort to a program of making low risk crop production the standard practice, rather than the exception, in the various areas of the state.

Proper land use in South Dakota was the big objective. In its broad sense this meant a proper standard of living for the farm family: right size of farm unit, right choice of farm enterprises, right choice of crops, crop rotation, soil maintenance and building, in fact, everything associated with proper management.

Norgaard also conceived the idea and implemented the program of "farming around July" to reduce the risk of crop failure.

Normally the annual precipitation ranged from 26 inches in the extreme southeastern corner of the state to 13 inches in the extreme northwestern corner. A major portion of the moisture was available in May and early

June, then came a hot, dry July and more precipitation in late August and September. The shortage of moisture became more acute in areas with lower annual precipitation. Long-season crops, such as corn, required a relatively large amount of moisture during July. Consequently, it did not do well except in southeastern counties.

The educational program promoted the use of sorghum, perennial forages and early maturing varieties of small.

Early small grains matured before they could be damaged by hot, dry weather. Sorghum had the ability to go dormant during periods of moisture stress and recuperate when rains came late in the year. They were superior to corn in this respect and better adapted in areas of limited rainfall. Farmers were encouraged to plant 25 to 30% of the cultivated acreage to tame perennial grasses and/or alfalfa.

In 1945 the Extension agronomist, entomologist and soil conservationist conducted 33 crop hazards schools over the state. Overcoming the hazard of too little moisture and erosion of soil by wind and water by various practices were discussed as a means of overcoming these hazards.

Every year from 1945 to 1959, agronomists suggested that each farmer should, as he planned his operation, ask himself three important questions: What shall I plant? How much shall I plant? How shall I plant?

Before he could answer these questions he must, to be successful, consider all the following factors; soil, climate, livestock, pests, markets, prices, labor and standard of living.

Agronomists believed that crop production could be improved. In spite of the natural hazards of drought, heat, grasshoppers and other insects and diseases, an adequate supply of crops for both the livestock and cash market could be produced by using modern soil and moisture conserving practices by choice of adapted drought-, heat-, disease- and insect-resistant or escaping crops and varieties (including annuals, biennials and perennials) and farming around the natural hazards in all areas of the state.

The Extension agronomy program aimed at alleviating the following situations:

1. Low crop yields on account of limited moisture supply.
2. Crop failures because high risk crops for the area planted.
3. Crop failure because of use of high risk varieties for the area.

4. Loss of crops from preventable crop diseases.
5. Loss of crop yields because of use of weed infested and diseased seed.
6. Loss of crop yield and quality from weeds.
7. Loss of crops from insects and rodents.
8. Loss of crops from poor cultural practices such as "stubble in", wrong time, rate and depth of seeding.
9. Loss of feeding value, market value of feed crops and cash grains because of improper time of harvesting, threshing and storage damage.
10. Loss of crop yields because of depleted soil fertility.
11. Loss of cheap feed source due to depleted, overgrazed pastures.

In 1953 approximately 43 million acres provided revenue for agriculture--14.6 million in cultivated crops, 27.2 in native grass and 1.2 in tame grass and legumes. It was suggested that the acreage of tame grasses and legumes be increased to 5.9 million and the acreages be reduced to 13.6 million for row crops and small grain and 23.7 for native grass (Bul 427).

During the spring of 1952 one of the worst Missouri River floods on record occurred. It created one of the many "crash" programs that Extension agronomists encountered. Considerable time was spent helping farmers and ranchers decide what to do with the flooded land.

A 3-year program was launched in 1958 to promote the use of Teton alfalfa, a new pasture-type variety, for use in pasture mixtures. The production and marketing of seed was discussed at eight district meetings during the first year.

The next year an inter-departmental pasture handbook was prepared. Cline and Sanderson included suggestions for establishment, Williamson and Davis discussed pasture rotation, Wallace emphasized weed control and livestock specialists gave suggestions for grazing management.

Winter barley was attracting considerable attention among growers in south central counties. Extension agronomists in 1959 discouraged the use of the crop. Existing varieties had very weak straw and were not winter hardy enough to withstand most winter conditions.

A shortage of durum wheat in 1959 prompted a special program, requested by the milling industry, for durum wheat. With assistance from the Extension agricultural information specialists, Sanderson and the wheat breeders

produced radio tapes and news releases on which the uses and need of durum, areas of adaptation, recommended varieties and some production tips were discussed. The radio tapes were sent to Clinton Zinter, former county agent, of The Peavey Co. for use in promoting the crop.

Variety Demonstrations

The crop variety demonstrations headed the list of activities in the Extension Agronomy educational program (Ext-24).

Johnston and small grain breeder K.H.W. Klages planted the first small grain variety demonstration plots on the farms of private cooperators. The plots were also used as small grain performance trials (Bul 268).

Several varieties of spring wheat were planted in 1929 on three Brown County farms (Bul 256). The next year three to five barley varieties were planted on the farms of F. J. McHugh of Ordway, J. J. Wallace of Britton and T. C. Wenz of Bath (Bul 256). Three to six varieties of spring wheat were planted on each of 15 farms in northeastern South Dakota (Bul 268).



Early barley variety demonstration.

Crop variety demonstrations in 1931 included corn, small grain and flax. In order to produce more corn in northern and western counties to feed the ever growing numbers of livestock, 12 to 15 corn varieties were planted at different locations in 10 counties to show which varieties were best adapted to those areas. Small grain variety demonstrations conducted at 13 locations included six to eight varieties of spring wheat, five of barley and six of oats. Wheat and barley demonstrations were conducted in Grant County, oats was added in Brown and flax was added for a total of four crops in Codington, Day and Marshall counties.

Norgaard assembled seed of small grain, corn, sorghum and soybeans in 1941 and assisted county agents in organizing 32 wheat, 45 barley, 43 oats, 17 flax, 69 corn, 88 grain sorghum and four soybean variety demonstrations.

The SCS provided 60 pounds of six grasses for each county agent. They were planted in species demonstration plots in all counties that had county agents. Russian wildrye trials were conducted in 25 counties.

Hybrid corn became more important during the 1940s. In 1947, 43 corn hybrid county demonstrations were conducted. Sanderson secured seed of open-pollinated varieties to be compared to hybrids that were being sold in the county. County agents were given instructions on how to determine yield and take notes on standability, disease and insect resistance, maturity and other factors.

Around the turn of the decade, county crop improvement associations began to assist the county agent with variety demonstration plots. They helped select areas for the demonstrations, tend the plots and sometimes helped harvest yield samples.

By 1951 there were 198 small grain variety demonstrations (53 wheat, 60 oats, 57 barley and 28 flax) in 50 counties. Also there were 34 corn hybrid demonstrations, that included 10 varieties in 18 counties.

Three years later there were 240 small grain variety demonstrations (11 winter wheat and rye, 52 spring wheat, 27 durum, 62 oats, 57 barley and 31 flax) in 52 counties, 29 corn hybrid demonstrations in 24 counties 19 soybean 9-variety demonstrations in 18 counties, and 22 sorghum 14-variety demonstrations in 17 counties.



V.A. Dirks at variety demonstration tour-1950s.

County agents were provided with report forms for small grain demonstrations and instructions for taking notes on maturity date, standability, disease, length of straw and insect resistance. Sacks were provided in which yield samples were sent to Cline and Sanderson. They threshed the samples and determined test weight. Bushels per acre were

calculated and sent to the respective county agents and cooperators.

Also a mimeographed circular was prepared annually which included a history and description of each variety in the demonstration. Though county agents had the information needed to conduct tours of the plots, Nor-gaard, Cline, Sanderson or Ladd conducted a majority of the tours.

Sometime during the late 1950s the county crop improvement associations became more active in their sponsorship of the variety demonstration plots. They not only helped select a cooperator, but paid for the cost of seed and sponsored tours of the plots.

Several counties held tours on Sunday and made a family event of it. In Day County, for example, the selected cooperator not only provided space for the plots but also provided a grove, benches and tables for a pot luck picnic. Before eating, an invocation was given. Afterwards, some farmers showed sheaths of new varieties they were growing. Others showed corn plants from fertilized and unfertilized areas in their field and others discussed a noxious weed. Then an Extension agronomist led a tour of the small grain variety demonstration plots. Brown, Beadle, Pennington, Dewey and Ziebach counties held similar types of tours. Most other counties had evening tours.

During 1959, 56 counties conducted 47 spring wheat demonstrations--30 of durum, 17 of winter wheat and rye, 60 of oats, 57 of barley and 34 of flax, for a total of 245 small grain and flax demonstrations.

Thirteen corn hybrid demonstrations were conducted in ten counties. Fifteen varieties were included in each of 17 soybean demonstrations in as many counties and 33 varieties and hybrids of grain and forage sorghum were included in 20 sorghum demonstrations.

EXTENSION SOILS PROGRAM 1937-1960

An appropriation in 1929 provided for conducting soil erosion investigations, and soil erosion experiment stations were established under the Bureau of Soils, USDA. Four years later the Soil Erosion Service was established in the USDI to conduct soil erosion investigations (LL-4).

The legislation for the Soil Erosion Service provided for soil erosion control demonstration projects and for Civilian Conservation Corps (CCC) camps to provide labor and machinery to conduct the demonstrations (LL-4).

In 1935 the name of the Soil Erosion Service was changed to Soil Conservation Service (LL-4) and sometime before 1937 the SCS was transferred back to the USDA.

The CCC camps served a dual purpose. They provided employment for the nation's youth and World War I veterans and provided labor for conservation of natural resources (LL-5). Though many CCC camps in South Dakota were operated by the U.S. Forestry Service, camps at four locations (Alcester, Huron, Chamberlain and Sturgis) were operated by the SCS. Side camps were located at Vermillion, Presho and Miller.

Dam construction was a major activity. Some of the dams include the masonry dams across the James River at Third Street in Huron and one in Spink County. An earthen dam on the Crow Creek at Chamberlain, the Brakke and Fate Dams near Presho and the Lake Dakotah Dam near Miller were also constructed (LL-6).

Other conservation practices included strip cropping, rough tillage and shelterbelts to prevent wind erosion, and contouring, contour cropping, contour furrows in pastures and terracing to prevent water erosion (LL-6).

During the mid-1930s the Soil Erosion Service hired J. G. Hutton of the Agronomy Department at SDSC to conduct educational meetings throughout the state to discuss soils--how they were developed; what they provided; how structure, organic matter and nutrient content were deteriorating; and the need to prevent wind and water erosion in order to protect this natural resource (LL-7).

Soil Conservation Districts

In 1937 the State Legislature passed a law which established the State Soil Conservation Commission (LL-7) and outlined the procedure for establishing soil conservation districts (LL-8). This was an Extension function and Ralph E. Hansen was employed as Extension Conservationist in October that year.

He continued to hold the type of meetings conducted earlier by Hutton. Much of his time was devoted to the organization of conservation districts. A total of 32 were organized during his 7-year tenure.

Hansen took charge of the Dakota Zephyr, a mimeographed newsletter, during the early 1940s. The first issues were written and circulated by the SCS. After Hansen became the editor, SCS personnel and district supervisors provided information for the quarterly. The publication was printed, starting in November, 1943, at Extension Service expense for several years. However, several districts started to

circulate their own newsletter and the Dakota Zephyr was discontinued during late 1946 (LL-27).

A Soil conservation teaching unit was prepared in 1943 for the rural schools of Meade, Perkins and Ziebach counties. It was developed by a high school superintendant, two county agents, three rural school teachers, three SCS specialists and Ralph Hansen (LL-32).

A second edition was prepared later in the year by Hansen and another committee. Entitled "South Dakota Teaching Unit for Soil Conservation for Grade Eight", it contained fourteen lessons for use over a 6-week period in Unit I of "Earth and Changes" (LL-32).

Each lesson was outlined as problem, objectives and subject matter and concluded with a comprehension exercise. Each lesson was illustrated by appropriate pictures or drawings (LL-33).

Hansen's successor, Leonard L. Ladd, continued the major educational program of organizing new districts. When a new district was being organized, the county agents were supplied with samples of news stories, circular letters and information sheets on a district--what it was and how it operated.

By 1945 a total of 1,981,177 acres was organized into districts--320,917 acres in one new district and the remainder in additions to eight existing districts. At the end of the year one county was ready to vote on the question of whether it should be organized into a conservation district. Two districts were ready to vote on the inclusion of the remainder of the counties into existing districts and four were circulating petitions to secure a vote on the same question. A total of 14,870,909 acres (30% of the cropland and 40% of the acreage in the state) had been organized into conservation districts.

Ladd organized the first soil and moisture conservation clinic in 1951. The Greater South Dakota Association sponsored it as a scholarship award for farmers recognized for soil and water conservation programs. For many years the farmer selected as the number one conservationist in his district won the award.

Ladd and his successors, Williamson, Adams and Schoper, organized 30 clinics on the campus of SDSU. Speakers on the 3-day program included staff members from several departments--Agronomy, Animal Science, Agricultural Engineering, Economics, Sociology and others. Around 1970 the length of the clinic was shortened to 2 days and spouses were invited to attend.

An outline was developed in 1945 for district supervisors to use when developing a plan of work and writing an annual report. Also, a memorandum of understanding between soil conservation districts and the Extension Service was developed.

Two new districts were organized during 1955. The Jones County district and the Perkins County district covered an area of 1,915,207 acres.

By the end of 1955 there were 66 soil conservation districts covering an area of 36,030,373 acres of land in farms and ranches. The area included all of 59 counties and part of another county. Only five counties and part of one remained unorganized. The unorganized counties were Edmunds, Walworth, Faulk, Douglas, Hutchinson and part of Lyman.

Preliminary educational work on district organization was initiated in Edmunds, Walworth, Faulk, Douglas and Lyman counties.

When Ladd retired in 1956, 69 districts had been organized. Williamson continued to organize districts. By 1959 some reorganization had taken place and all counties but Douglas, Faulk, Hutchinson and east Corson were organized into 65 districts which included more than 90% of the farmland in the state. Hutchinson was organized in 1961 by Williamson and Douglas County in 1966 by Adams.

Handbooks were developed in 1959 as guides for district supervisors when fulfilling their many responsibilities.

Other Conservation Programs

During the late 1950s, the Great Plains Conservation Program was inaugurated by the SCS. Extension soils specialists attended inter-agency meetings where each agency explained its part in the program. Extension publications were prepared and farmer meetings held to explain how the program would help stabilize agriculture.

The Soil and Water Conservation Needs Inventory was completed in 1959 in cooperation with the SCS. The state inventory was later included in the National Soils and Water Needs Inventory which was a valuable document used by several agencies for planning.

Conservation Demonstrations

During the early 1940s, farmer cooperators were asked to sign agreements to use their farms as demonstrations of such conserving practices as improved range management, water spreading, improved irrigation systems, grassed waterways, contour cropping, drainage

ditches and windbreaks. Trees were provided for the first time in 1943 and 57 demonstration farms, covering 30,922 acres in 26 counties, were established. Agreements were obtained by the Extension Conservationist, SCS technicians or by a "widespread application program." By the end of 1943, 180 farms and 108,579 acres operated under such agreements.

In cooperation with the SCS, Ladd organized five tillage and farm terrace-building demonstrations in 1949 and one each on pot hole drainage and contour farming. Tillage demonstrations were used to encourage the 746 attendants to use fall tillage to conserve moisture and control weeds.

For each demonstration implement dealers were invited to bring machinery--moldboard plows, wheatland plows, one-way disks, "gobal" disks, chisels, duck-foot cultivators, blades and rod weeders. Ladd explained the merits of each type of implement for controlling weeds, conserving soil moisture and preparing a seedbed. Then each implement dealer in turn had an opportunity to discuss his own machine and make two rounds in small grain stubble to demonstrate it.

During 1950 tillage demonstrations were held in Aurora and Jerauld counties, tillage and terrace building in Spink, terrace-building in Yankton and tree planting demonstrations in Haakon County.

Tillage demonstrations were held at several locations in the state almost every year until the present (1980).

Soil Fertility

Demonstrations with phosphorus fertilizer, mostly on corn, were started in 1926. Because of the drought in 1930, the number of demonstrations dropped to 56 in nine southeastern counties in 1931.

These demonstrations were continued by Johnston and his successor Norgaard on a limited basis. They contended that a legume in the rotation would provide nitrogen needed by other crops, but phosphorus was needed on corn and alfalfa.

With the establishment of the Soil Testing Laboratory in 1947, more emphasis was placed on fertilizer demonstrations by Extension agronomists and Extension conservationists.

In 1948 Ladd assisted county agents with 156 fertilizer demonstrations. The number dropped the next year to 145 in 41 counties. Each demonstration included four 1/30-acre plots, with an untreated plot and three fertilized plots. One rate of nitrogen, one of

phosphorus and one of both elements were applied in 53 small grain and 39 corn demonstrations. Three rates of nitrogen were applied in 31 perennial grass demonstrations and three rates of phosphorus in 32 alfalfa demonstrations.

Sanderson in 1949 packaged and supplied commercial fertilizer for 86 demonstrations (17 corn, 26 small grain, 23 perennial grass, and 20 alfalfa) in 20 counties, using treatments similar to those used by Ladd.

During 1950 Ladd helped county agents conduct demonstrations in 42 counties. Small grain was the crop in 57 demonstrations, grass in 45, alfalfa in 36 and corn in 24.

Though Soils specialists directed much of their attention to the TVA demonstration program, crops specialists continued their demonstrations for more than a decade. Many times enough fertilizer was provided to fertilize one or more strips across the varieties in the variety demonstration plots.

Crops and soils specialists continued to advocate the use of grasses and legumes in the crop rotation to improve soil tilth and fertility. Soils specialists conducted educational programs on the role of soil microorganisms, residue management, fertilizer use and soil testing.

The objectives in 1959 were to promote the use of more grass and legumes in cropping systems, secure increased use of fertilizer as a soil management practice and induce farmers to submit 3,000 soil samples for soil testing.

An attempt was made to organize a 4-H project in soil sampling. 4-Hers in Minnehaha County were trained to take soil samples and submit them for tests with the intent that the idea become a permanent 4-H project. It never did.

TVA Demonstrations

Ladd, in 1949, made arrangements with the Tennessee Valley Authority to conduct cooperative fertilizer demonstrations in South Dakota. After several meetings with Experiment Station staff, Extension administration and TVA representatives, a memorandum of agreement was developed.

The "test demonstration" program was inaugurated in 1950. The objectives of the program were to (1) introduce new fertilizer developed by TVA, (2) promote efficient and economical fertilization practices, (3) encourage greater use of grasses and legumes in the cropping system, (4) promote soil testing as a basis for fertilizer application, (5) demonstrate on

farm scale that research was essential and (6) develop complete farm and home plans.

The program was conducted under a state committee. Counties were invited to submit requests for the demonstrations. The state committee based the selection of counties on the soil associations that occurred in each county. An organization (SDCIA, Conservation District Supervisors or Extension Board) within each selected county then chose four or five cooperators based on the soil type within the specified soil association.

Each cooperator signed an agreement to conduct a complete farm and home plan that included the use of a specified crop rotation, the keeping of complete farm records, the use of recommended soil and water conservation practices, determination of yields on fertilized and unfertilized areas and gave permission to use the farm for tours.

In 1950 the four cooperators, (two each in Deuel and Minnehaha counties) used 69,900 pounds of superphosphate, obtained at a reduced cost, on 471 acres. Yield increases ranged from 0 to 300%.

In 1955 there were 29 cooperators in 14 counties. Entire fields were fertilized with check strips left in each field. 122 tons of concentrated superphosphate were applied on 80 fields, and 49.7 tons of ammonium nitrate were applied on 51 fields.

The response of legumes to phosphate over a 5-year period indicated definite trends. Increases of legume hay yields on a county average were: Beadle 34%, Butte 12%, Charles Mix 25%, Clay 13%, Deuel 55%, Lawrence 12%, Lincoln 18%, Meade 16%, Minnehaha 38%, Roberts 32%, Sanborn 18%, Sully 32%, Tripp 16% and Todd 15%.

A group of representatives from TVA was taken on a tour of three demonstration farms and the Summers fertilizer plant.

Four years later there were 38 cooperators in nine counties. More than 337 tons of ammonium nitrate, ammonium phosphate nitrogen, diammonium phosphate, concentrated superphosphate and calcium metaphosphate were applied. Farmer tours were held on several of the farms.

The "distributor demonstration" program was initiated during the late 1950s. The main purpose of the program was to encourage eligible dealers to sell TVA fertilizers to farmers who would cooperate in the demonstration of the fertilizer. In 1959 an educational program was conducted to familiarize fertilizer dealers with the test demonstration pro-

gram, report results from that program, report fertilizer research results and promote soil testing among dealers and assist dealers with the farmer organization meeting.

Know Your Land and Grassland

In cooperation with the SCS, Ladd and Switzer inaugurated the "Know Your Land" program in 1953. The program was patterned after that developed at Oklahoma State for the purpose of providing a new method of teaching soils and soil conservation to 4-H members and vocational agricultural students in high school (LL-27).

By 1955 the program was developed as an educational tool in the teaching of soils and soil management to youth and adult groups. Every vocational agriculture class and vet's agriculture class in the state used the "Know Your Land" material as a part of their course work. Many 4-H clubs also used this method of teaching soils. The number of farmers attending schools was rather small.

An area land judging contest was held at Mitchell. Eleven counties participated. One team each for 4-H, FFA and adults was chosen through an elimination contest to represent South Dakota at the national contests at Oklahoma City.

The number of area land judging contests increased to four by 1959-Aberdeen, Watertown, Mitchell and Sioux Falls. At each location a school was held during the forenoon to help students recognize soil factors used in soil management and give instructors some ideas for teaching soil management.

The judging contest was held during the afternoon. The four top FFA and four top 4-H students at each of the Aberdeen and Mitchell contests became members of four 4-student teams. One team each of 4-H and FFA members was selected from those who judged at the other two locations. Williamson accompanied the teams to the national contest.

In 1954 Cline started to develop a "Know Your Range Land or Grassland judging program in cooperation with SCS representatives. He conducted a training session for county agents and representatives of SCS and other agencies.

EXTENSION WEED PROGRAM 1947-1960

For a quarter century the weed work was done by Extension agronomists. In 1931 there was much interest in the use of clean cultivation and the chemical, sodium chlorate, to control field bindweed, Canada and perennial sowthistle, leafy spurge and quackgrass.

Johnston routed a Chipman Chemical Engineering Co. spray truck to 21 areas in 10 counties, and the use of sodium chlorate was demonstrated to 813 people. A total of 159 demonstrations was conducted in 16 counties. Demonstrations included the use of clean cultivation in seven counties and \$30,000 worth of sodium chlorate in ten counties.

In 1941 Norgaard started to work with a SDCIA committee to develop new weed and seed laws and cooperate with the AAA on its weed program. In addition, he helped five county agents conduct demonstrations on the use of cultural methods to control field bindweed and led a 150-man tour of southeastern counties to show the seriousness of the weed.

The new weed law sponsored by the SDCIA was passed by the 1945 Legislature. It named the members of the 9-man State Weed Board, authorized the hiring of a state weed supervisor and specified that Extension be responsible for the educational program.

When an appropriation was made to the State Weed Board in 1947, it included \$10,000 for Extension, making it possible to implement a full fledged Extension weed program. Elmer Sanderson left his post as Assistant Extension Agronomist in April to serve as the State Weed Supervisor. When William Klatt was employed for that position in July, Sanderson returned to Extension and devoted nearly full time to the weed program for about 6 months.

The specialists and county agents conducted 270 weed meetings during 1947. Demonstrations were given on different types of spraying equipment, how weeds should be sprayed and on various chemicals. Publications with color illustrations were produced on four noxious weeds: creeping jenny, perennial sow thistle, perennial peppergrass and leafy spurge (Ext 25).

Leonard L. Schrader became the first Extension Weed Specialist on January 1, 1948. He continued to spend considerable time on the organization of county weed boards, but also discussed the use of cultivation, soil sterilant chemicals and the new herbicide 2,4-D for controlling weeds.

In 1950, 460 weed meetings were conducted. Weed identification slides were made for county agents' use at the meetings. The use of sprayers, rates of application of 2,4-D and time of application were timely subjects discussed at the meetings. South Dakota had 2,236,000 acres of crops treated with chemicals for weed control during the year (Ext 25). By the end of the year, 47 county weed boards had been organized.

After county weed boards were organized, it was necessary to train those involved in the weed program. In 1951 a 2-day shortcourse was held for county agents, county weed supervisors and county weed board members. Aerial sprayer operators attended another 2-day shortcourse. Schrader and Cline conducted five weed and range schools to train 371 4-H club members who displayed 150 range and weed books at the Western Junior Livestock Show in October. Twenty educational and organizational meetings with an attendance of 1875 were held.

Lloyd R. Wilson became Extension Weed Specialist on January 1, 1952. The first district weed meeting was held that year. It included county agents, county weed board members, county weed supervisors, county commissioners and township weed representatives from four southeastern counties.

At that time, it was estimated that noxious weeds caused losses of \$40 million annually. The amount was about half the amount that the legislature appropriated for a biennium.

About 3 million acres of crop were sprayed with 2,4-D in 1951 by 75 licensed aerial applicators and about 9,000 ground rigs.

Wilson started providing herbicides for noxious weed control demonstration plots. Seven counties had demonstrations in 1952, 12 in 1953 and 23 in 1954. Also in 1954 the weed research staff sprayed flax plots in five counties to demonstrate the use of several chemicals for controlling annual weeds in that crop. The first weed tour, attended by chemical company representatives, state and county weed workers and farmers, was conducted. They observed the demonstrations in nine counties.

Organizational meetings in 1954 were held in Brule and Tripp counties. Brule County became the 52nd county to elect a county weed board. U. J. Norgaard believed that the seventh year of the program was critical. If the program survived that year, it would continue. Consequently, special effort was made to rejuvenate the organizations in seven counties that were beginning to show a lack of enthusiasm.

Five dealers' schools were held in 1954. Extension specialists in weeds, soils and entomology trained agricultural chemical dealers on the characteristics and uses of fertilizers, herbicides and insecticides.

Keith E. Wallace became the third Extension Weed Specialist in July, 1954. He continued most of the programs established by his predecessors--attending State Weed Board meetings, helping man the State Weed Board booth

at State Fair, and conducting district weed meetings, weed control demonstrations, state weed tours, dealers' schools, aerial applicators' shortcourses, county weed workers' shortcourses and farmer meetings.

However, most of the counties had organized weed programs and more weed research information was available on weed control methods. Therefore, he spent less time on the discussion of the needs for weed control and more on methods of controlling weeds.

When discussing methods of controlling weeds, he followed the philosophy that clean seed, proper seedbed preparation, good rotations and sound soil management practices were required for controlling weeds in crops. These practices would eliminate many annual weeds and prevent infestations of most perennial weeds. Herbicides were valuable supplements to these practices, but were not intended as a replacement of sound management practices.

Once weeds became established, special practices were needed to eliminate them. Special cultivation, competitive crops, and herbicides, in addition to the practices already mentioned, were helpful. A single method or application seldom eliminated all perennial weeds. Once they are eliminated, new seedlings from seeds in the soil needed to be controlled. Some of these seeds would remain viable for as long as 20 years.

By 1959 all but 12 of the 67 counties had active weed boards. They had conducted noxious weed surveys and reported a total of 1,285,212 acres of field bindweed, 224,138 of Canada thistle, 291,026 of perennial sow-thistle, 150,249 of quackgrass, 67,000 of leafy spurge, 910 of hoary cress, 557 of Russian knapweed and 44 acres of horse nettle.

Because of the large infestation of some species, the objectives of the weed program were to control large infestations of field bindweed, thistles and quackgrass and eliminate small infestations of these weeds and each of the other four species of noxious weeds.

Wallace attended 16 county weed meetings, eight district meetings, the State Weed Conference, conducted a district county agent training session in Watertown, assisted with the aerial applicators' shortcourse, took charge of SWB exhibit at State Fair and provided chemicals for 21 weed control demonstrations.

The demonstration plots included nine soil sterilants--Concentrated Borascul, TBA, PBA, DB Granular, Amate, Erbon and Chlorea.

Wallace worked with Derscheid in the formulation of the ACP cost sharing program conducted by the ASCS. A total of \$260,000 was spent in 1959 to eliminate noxious weeds on 80,000 acres.

EXTENSION WATERSHED PROGRAM 1955-1962

Joseph T. Paulson, the only person to serve as Extension Watershed Flood Control Specialist, was appointed on December 1, 1954. His assignment was to do the educational work required for the watershed program in the Big Sioux River Valley.

The overall watershed program involved the development of several flood control projects on the tributaries. Before channelization and other stream improvements could be performed at U.S. Government expense, it was necessary for farmers and owners to conduct conservation practices to protect the upland as well as lowlands from water runoff and soil erosion--such practices as contour farming, pasture furrows, terraces, grassed waterways and water retention dams. The objective of each project was to provide an outlet to the Big Sioux and control flooding without causing floods in another area.

First Year

The projects that were considered were on Deerfield Creek in Deuel and Brookings counties, Silver Creek in Minnehaha, Patee Creek in Lincoln, Butte Creek in Lincoln and Union counties, and Union and Richland Creeks in Union County.

The 3000-acre Scott Creek project in Union County had been almost completed. The North Deer Creek project in Deuel and northern Brookings County had been approved for soil conservation work, and the Silver Creek project in Minnehaha had been approved by the SCS and a report sent to Washington, D.C.

Deer Creek

A half dozen local meetings were held to explain the project and encourage farm leaders to apply conservation practices on their land to demonstrate the value of the practices to their neighbors.

Studies were initiated to determine the advisability of diverting the water from upper Deer Creek in southeast Deuel County and northeast Brookings County into Lake Hendricks. A dozen farmers toured the Scott Creek project. They organized the Upper Deer Creek Watershed Committee.

Silver Creek

The idea of watershed flood control was discussed at two meetings and a committee of ten was chosen to promote the development of the watershed. About 110 farmers attended the next two meetings in Baltic and Renner and 20 more were interviewed. Objectives of the meetings and interviews were to further explain the purpose of the program and to learn what farmers wanted to do.

The watershed included 23,000 acres on 141 farms. Only 8,000 acres were subject to flooding and it was difficult to convince farmers in the 15,000 acres of upland that the use of conservation practices on their farms was essential to the success of the project.

Pattee-Oakland

The Oakland project had been approved for a survey and part of the surveying had been done. However, the Pattee and Oakland were part of the same hydrological unit and it was felt that the two should be organized together. Farmers in the Hudson area visited the Scott Creek project and voted to ask the Oakland organization to include the entire Pattee Creek watershed in their plans.

Conservation practices had been established on very few acres in the watershed.

Union Creek

The creek flowed from near Alcester to near Akron, Iowa, where it flowed into the Big Sioux. About 15 farmers toured the Scott Creek project, but few conservation practices were being used, farm land was badly eroded and the farmers had little enthusiasm for a watershed project.

Richland Creek

This small creek flowed into the Big Sioux near Elk Point. A group of farmers toured the Scott Creek project, formed an organization, set up committees and made application for state and federal approval, a survey and a plan of work.

Brule Creek

The Brule Creek watershed comprised 145,000 acres in Lincoln and Union counties. It was very destructive. It removed good soil from fertile crop land, flooded lowlands along its course and flooded bottomland where it entered the Big Sioux. It poured tons of topsoil and silt into the Big Sioux, obstructed its flow and caused it to flood adjacent crop land.

Farmers and land owners were beginning to think that something should be done about the situation.

Later Years

For the next several years Paulson conducted educational programs to explain what takes place during soil depletion and soil and water loss. This was to demonstrate that conservation practices protect the land from erosion and illustrate that erosion from upland farms damages lowland farms, cities and towns downstream.

He also explained that the Watershed Authority gave direct authority, taxing rights and other powers to local people so they could cooperate with the Federal Government in a watershed program and properly conduct their part of the program. He attempted to convince people that the federal watershed program would help them and that an organization could secure federal aid.

During 1960, Paulson was concerned with 22 watershed projects. Wild Rice Creek in Marshall County, Silver Creek, in Minnehaha, Pattee Creek in Lincoln and Scott Creek in Union County were organized and in the construction stage. Green Creek in Lincoln and Union counties and Upper Little Minnesota in Roberts County were organized, but had no finance plan and had not voted on construction. Turkey Ridge Creek in Lincoln, Brule Creek in Lincoln and Union and Marne Creek in Yankton were in the organizational stages. Lower Crow Creek in Brown, Upper Crow Creek in Marshall, Upper Deer Creek in Brookings and North Fork Whetstone in Roberts County were preparing for organization. Tewaukon Creek and Veblen Creek in Marshall County were considering organization. North Deer Creek in Brookings; Butte Creek in Custer and Pennington Counties, Richland Creek in Union, East Branch Vermillion River in Kingsbury, Lake and McCook counties; Middle Fork Vermillion River in Lake and McCook; Ponca Creek in Gregory; and Spring Creek in Charles Mix County were in the early educational stage.

EXHIBITS

Like demonstrations, exhibits were used extensively in the Extension programs, especially during the 1950s and 1960s.

Johnston and H. M. Jones, the Extension Dairyman, played a major role in the conduct of the "Alfalfa and Sweetclover Special" train in Eastern South Dakota during the winter of 1925. Its purpose was to promote greater acreage and the use of these crops as the most reliable, permanent and productive sources of feed for maintaining livestock on South Dakota farms under all conditions (JW-31).

Starting in 1949 a booth or exhibit was developed, erected and manned annually by

Extension agronomists for the SDCIA at State Fair. A different topic was emphasized every year for about 15 years. Both crops and soils specialists manned the booth from time to time. Sheaves of new crops always attracted attention. Since the mid-1960s, the display has included sheaves of new varieties and a certified seed show.



Aboard the Alfalfa Sweetclover Train.

The SWB also started to sponsor an exhibit at State Fair in 1949. For about 20 years, the Extension Weed Specialist spent several days each year visiting with weed fighters that stopped at the display which usually featured one or more of the noxious weeds.

Large Displays

Extension Agronomy featured several large displays. Most were constructed by Tom Strachan, County Agent of Lyman County, and financed by the SDCIA. All were displayed at the SDCIA annual meeting and other large agricultural gatherings, generally by Strachan but sometimes by Sanderson and Cline.

South Dakotas Green Gold--Preserve It, Improve It" was an 8- x 64-foot display of legumes and grasses that was first displayed at Rapid City in 1949. Others included "Story of Sorghum Production in South Dakota", "What's Your Hay Worth", "Steps in Wheat Improvement" and "Grassland Plants--Some Good and Some Bad."

The latter was 11 feet high and 64 feet long. It included plant mounts of 17 native legumes, eight poisonous plants and 71 forbes. Green labels were used for native legumes, red ones for poisonous plants and white cards for forbes to tell a little about each species. In 1954 it was shown at several large agricultural meetings in the state as well as a western states regional meeting in Fort Collins, the national meeting of range manage-

ment in Omaha and the USDA grassland exhibit in Washington, D.C.

Traveling Exhibits

Extension agronomists provided one to three exhibits for each of the seven traveling exhibits conducted by the Extension Service during the 1950s and 1960s.

The 1950 show, entitled Farming in the Fifties, included nine booths. Ladd prepared and manned the conservation booth which compared the characteristics of soil that had been continuously cropped with those of soil on which with a crop rotation containing grasses and legumes had been raised, to show the advantages of the crop rotations.

In the crops booth, Sanderson and Cline emphasized use of early maturing small grain varieties to escape the weather hazards of July and August. Not overlooked was the fact that good soil fertility was needed to get maximum yields from the varieties. The use of grass and legumes in a rotation and the use of sweetclover as a green manure crop were suggested as ways of obtaining good soil fertility.

A year later Extension agronomists manned two of the booths in the "Family Farming" traveling exhibit. The Crops booth told the story of nitrogen by showing that nitrogen could be added to the soil by the growing of legumes. It depicted a 3-year rotation which included a crop of sweetclover and used sacks of nitrogen to illustrate the amount of nitrogen added by the legume.

The soils booth at State Fair and "Family Farming" traveling exhibit was entitled "The Story of Nitrogen." The exhibit consisted of a large background panel on which a chart illustrated that a tremendous amount of nitrogen was added to the soil whenever a crop of sweetclover was plowed under as a green manure crop. On either side of the chart, sheaves of fertilized and unfertilized alfalfa and grass showed that production of both crops was greatly increased by fertilization. The roots of grasses and alfalfa were displayed on side tables along with samples of nitrogen fertilizer.

"Fortified Farming" included 11 subject matter exhibits in 1952. The crops exhibit included sheaves of adapted oats, barley and flax varieties mounted on a wheel behind a wall. A triangular opening in the wall allowed the showing of only one or two varieties at a time. The use of adapted varieties was stressed as an essential factor for "efficient farming". Extension agronomists emphasized the need for good soil fertility and seed testing and demonstrated ways of testing for seed germination in the home.

"Soil is What You Make It" was the title of the soils exhibit for "Fortified Farming" and for State Fair. It emphasized that all soils do not have equal soil fertility and never did. However, the operator that assumed control of the land could improve it, maintain it or destroy it. Ladd and Switzer advocated the return of crop residues to the soil, plowing under of legumes as green manure and the use of commercial fertilizer when soil tests indicated a need to improve soil condition and increase yields.

Soil monoliths on the background illustrated differences between good and poor soils. Other displays included roots of alfalfa and grass, nodulated roots of alfalfa and different grades of straight and mixed fertilizers.

The weed exhibit was entitled "Keep Weeds off the Farm". It included mounts of the eight noxious weeds and emphasized that "it costs more to keep weeds than to kill them". Charts were used to compare the losses caused by field bindweed with the cost of eliminating it.

"Better Farming-Better Living" was the theme of the 10-booth traveling exhibit shown in 1954. Each booth was designed to illustrate how SDSC served the people of the state. Exhibits were prepared by each of the five divisions.

Agronomists concentrated on the Soil Testing Laboratory, Seed Testing Laboratory, Variety Performance Tests, soil fertility trials and the development of new varieties. They illustrated how seed testing and soil testing would pay for each farm, and how variety performance tests and soil fertility trials were used to determine which varieties were best adapted and how much fertilizer was needed in various areas of the state.

Agronomists had two of the ten subject matter booths in the 1957 traveling exhibit entitled "Family Farming in 1957".

"Keys to Successful Farming" was the title of the booth that Sanderson and Cline provided. A chart listed the following crop production practices: choose adapted crops, select adapted varieties, test all seed, treat all seed, conserve soil moisture, grow grasses and legumes in the rotation, plow under green manure, use commercial fertilizers as needed, prepare firm, well-tilled seed bed, use furrow openers for planting row crops on the contour and control weed and insect pests.

Sheaves of new varieties of small grain and sorghum, plastic boxes of seed of recommended varieties and vials of recommended herbicides were on display in the booth.

Williamson and Davis in 1957 discussed the question "Can This Year's Moisture Grow Next Years Crops?" The importance of good soil management (crop rotation, fertilizers, organic matter, soil conditioning and other topics) were discussed. However, the major objectives of the exhibit were to (1) demonstrate the importance of stored moisture for crop production, (2) show that different crops utilized different amounts of soil moisture, (3) show that different crops used soil moisture during different periods of the growing season and (4) emphasize the importance of this year's moisture for next year's crop.

Charts on the booth showed the amount of moisture required during different growth periods to grow crops of corn, alfalfa, oats and flax. The main attraction was a model of a corn plant through which water was pumped, illustrating the amount of moisture needed, the time it is needed and the need for moisture stored in the soil.

Three of the ten booths in the "Farm and Home Show", shown in 1965 and 1966, were provided by Extension agronomists.

"Stretch Your High Gain Pasture Season" prepared by Derscheid and manned alternately by Derscheid, Sanderson and Cline, emphasized the use of several pastures composed of different pasture mixtures in order to assure good "high-gain grazing" for 6 to 7 months of the year.

For each area of the state grass species adapted to the area were suggested for use during their periods of high productivity. In much of Eastern South Dakota, crested wheatgrass was suggested for early spring grazing, a brome-alfalfa mixture for late spring and early summer, a warm-season grass for mid-summer, and Russian wildrye for September and October. Crested wheatgrass was also suggested for early spring grazing in western areas followed by native range.

"Top Soil Management Insures Full Returns" was the title used by Langin and Adams in a booth that emphasized soil fertility and fertilization. The basic principles of soil fertility and the properties of commercial fertilizer were stressed when discussing fertilizer carry-over in dry years, proper rates of fertilizer for various crops in different parts of the state, time and method of applying fertilizer, soil sampling and soil testing.

K. R. Frost suggested the title "Crops and Robbers" for a booth concerning agricultural pesticides--herbicides, insecticides and fungicides. Frost, L. S. Wood, B. H. Kantack and W. L. Berndt alternately discussed crop

losses caused by the "fifth column sabotage" of weeds, insects and diseases and methods of controlling the pests.

More details about these exhibits were included in Chapter XI.

Information Booth

In 1973 Leon Wrage suggested that several specialists conduct an information booth at State Fair. Specialists in entomology, plant pathology, weeds and soils agreed to cooperate in the venture. Derscheid arranged for the space and Milo Potas, Extension visual aids specialist, built the 24-foot booth with the wording "INFORMATION IS OUR BUSINESS, Cooperative Extension Service, South Dakota State University."

An extensive advance publicity program was conducted: Lee Jorgenson, Extension news writer, sent out one news story to newspapers and periodicals, while he and Derscheid each sent a write-up to county agents for their columns. The clipping service found the news story in ten different papers--Jorgenson's story in 3 papers, and Derscheid's in eleven. Derscheid and Williamson were interviewed for the regular Extension radio farm program and Cal Willemsen, Extension radio specialist, sent out several public service announcements to radio stations. They must have been used rather extensively because many people had heard about the Information Booth several times--mostly by radio.



Information booth at State Fair in 1973.

Dan Johnson, program director for KESD-TV, and Willemsen produced a 30-minute PTV show in front of the exhibit. The show opened with a short interview with Kermit Pearson, Secretary of the State Fair Board. Dr. Young, Director of Extension, then emphasized that the College of Agriculture and Biological Sciences was divided into (1) Teaching, (2) Experiment Station and (3) Extension Service and briefly discussed the roles of each. State 4-H Leader John Younger discussed 4-H.

Derscheid then pointed out that there were 130 Extension workers in the county offices who were backed by 70 Extension workers on campus. He noted that most of the county agents and home agents were working at the Fair--working with 4-H, judging, etc. Many specialists were at the fair judging or working on exhibits sponsored by Veterinary Association, Safety Council, Weed Commission, Horticultural Society, Crop Improvement Association or a livestock group. This exhibit was an attempt to demonstrate the type of service that the Extension Service provides on hundreds of topics. Four specialists were working on four subject matter areas to demonstrate the type of service that can be obtained in Animal Science, Economics, Home Economics, Agricultural Engineering, and many other fields.

Harold Wood briefly discussed the county worker's role in Extension and Earl Adams, Leon Wrage, Ben Kantack, and Leon Wood made brief remarks concerning fertilizer, weeds, insects and plant diseases.

The program was aired on PTV at 6:30 the same evening.

Wrage prepared potted plants of 12 to 15 weed species and enclosed a flowering musk thistle plant inside a plastic covered frame 3 feet square and 5 feet high. Kantack and Berndt displayed several insect specimens and a grub-infested cow hide. Wood used several diseased plant specimens and the chemical application equipment for treating Dutch Elm Disease. Adams and Williamson featured soil sampling equipment and photos depicting the use of fertilizer.

The exhibit was manned by at least three specialists from 9 a.m. to 7 p.m. for 5 days and from noon until 7 p.m. on Sunday. Wood was present 4 days and answered questions on plant diseases. Wayne Berndt and Ben Kantack each spent 3 days discussing insects with people. Earl Adams spent 2 days answering questions about soils and fertilizer--Ed Williamson, Paul Carson, Ray Ward and Bernie Byrnes each one day. Leon Wrage and Lyle Derscheid each spent 3 days visiting with people about weeds. They kept an accurate count of the number of people (about one-third of the total) that contacted them until noon on Monday when the counter broke. Daily counts were 194, 191, 156, 235, 142, and 118--on several occasions, they talked with 20 people per hour.

Of the estimated 3,000 that attended the display, about 1,100 people asked questions about weeds. The remainder of the questions were about evenly divided between soils and fertilizer, insects and plant diseases. However, there were a few questions about

other topics, including nitrate poisoning, grasses for hay or pasture, crop varieties, care of ornamental flowers and shrubs, animal nutrition and plans for hog houses. These questions were forwarded to the proper Extension specialist after the Fair was over.

Twenty diseased plants (corn, trees, fruit and vegetables) were brought to Wood during the 4 days that he was at the booth. Twelve to 15 insect-infested specimens of corn, potatoes, fruit and vegetables were brought to Kantack and Berndt. Ten or twelve weeds were identified by Wrage and Derscheid. About 15 soil samples were checked by Adams, Williamson and staff members from the Soil Testing Laboratory.

One thousand copies each of nine "Picture Sheets" with color photos of insects were available in the booth. Visitors picked up about 8,500 copies. They also picked up 694 copies of fact sheets "Weed Control in Lawns" and 617 copies of fact sheet "Dutch Elm Disease," 148 copies of Greenbugs in Small Grain," 123 copies of "Anhydrous Ammonia," 120 copies of "Fertilizing Vegetables," 111 copies of "Weed Control in Shelterbelts," 94 of "Fertilizing Corn and Sorghum," 91 of "Fertilizing Small Grain," 87 of "Fertilizing Pastures," 85 of "Adjusting Hand Sprayers" and 84 of "Wild Hemp".

A total count of publications taken was 8,700 copies of 16 insect publications, 1,182 copies of 18 weed publications, 601 copies of 14 soils and fertilizer publications and about 700 copies of three plant pathology publications. Except for the colored plates of insects, most publications were handed out in response to questions that were received.

Some typical comments received at the booth were as follows:

1. "This booth is the best effort I've seen on Extension's part to obtain identity on its own."
2. "Oh, this is what Extension is."
3. "I heard more about this booth on the radio than the rest of the entire Fair."
4. From the Department of Agriculture booth at 11 a.m. on Wednesday, the second day of the Fair, "Boy, you must have had good publicity. I've already referred a half dozen people to you that were looking for the Information Booth."
5. From the SDCIA exhibit at noon on Thursday, "People sure are looking

for your booth. I must have sent 20 people over there so far."

6. "Every time I turned on the radio, I heard them talking about Derscheid and his gang."

The success of this exhibit was attributable to the efforts of a large number of Extension workers--communications specialists and county agents, as well as the subject matter specialists that worked in the booth.

The purpose of the booth was to demonstrate the type of service provided by the Cooperative Extension Service. Too often, it was felt that some other organization received credit for the work done by Extension workers. Therefore, it was anticipated that a different group of Extension specialists would handle the exhibit each year. However, no group was willing to do so.

The booth was continued in the same manner in 1974, but not in 1975. Reports from neighboring exhibitors indicated that dozens of people were looking for the booth in 1975 so it was conducted for 4 more years. Kantack did not participate after 1976 and Wood quit a year later. For 2 years, it was a weed and fertilizer booth. About 2,000 people visited the booth each year. In 1980 the Dean of Agriculture wanted to use the exhibit space for other purposes.

The weed portion of the exhibit was shifted to the State Weed Commission booth. Previously Wrage and Derscheid had alternated as the weed representative and both had been present for a limited time during "big attendance" days. At the new location in the same building, the two state weed supervisors and several county weed supervisors assisted Wrage. A new background was prepared by Milo Potas with funds provided by the South Dakota Association of County Weed Boards. The exhibit featured 40 species of growing weeds. With the additional manpower in the booth, more people stopped to discuss weeds. A total of 4418 contacts were made in 1980 and 4508 people stopped to discuss weed control in 1981 (Wrage).

LATER AGRONOMIC PROGRAMS 1961-1980

Many programs initiated by Johnston or under Norgaard's leadership were continued and others were inaugurated during the 1960s and 1970s.

One change was the period covered by annual reports. From 1960 to 1965, reports covered the calendar year January 1 to December 31. For the next 14 years, they coincided with the state and federal fiscal year of July 1 to June 30. However, starting in October 1977 the reporting year was October 1 to September

30 to conform to the new federal fiscal year. The new dates were similar to dates of November 1 to October 31 used during the 1930s and December 1 to November 30 used from before 1945 until November 30, 1959.

During the 1960s South Dakota was described as an agricultural state and a "land of infinite variety" as far as climate, soils, crops, weeds and land use were concerned.

The situation was described much as it has been described on pages 80 and 81 of this report.

The Extension Agronomy program in 1964 was part of project 3 of the "Agricultural Production Management and Natural Resource Use" program outlined by the Federal Extension Service. In South Dakota the agronomic phases were included under five major projects: (1) crop production, (2) soil management, (3) weed control, (4) cooperation with federal agencies, and (5) youth activities. Crop production included sub-projects of small grain improvement and production, row crop improvement and production, forage crop improvement and production, root crop improvement and production, pasture and range improvement and management, and high quality seed. Soil management included soil fertility and soil conservation, while weed control included a project on noxious weeds and one with annual weeds. Some of the sub-projects became major projects in later years.

The goal of the Extension Agronomy Program during the 1960s was to achieve a balanced program in all phases of crop production and soil management.

Specialists worked closely with the SCS, ASCS, State Game, Fish and Parks Department, State Highway Department, State Weed Commission, State Wheat Commission, SDCIA, S.D. Wheat Growers, Crop Quality Council and retail dealers of fertilizer, herbicides and seeds. The end result was a spirit of cooperation.

Crop Improvement and Production

As a result of soil and climatic differences, South Dakota encompassed the western edge of the oats, corn and soybean belts, the northern edge of the sorghum and winter wheat growing area, the southern border of the spring wheat growing area, the eastern section of the rangeland and a portion of the flax-seed, malting barley and durum wheat zones. In addition, South Dakota farmers produced bluegrass seeds, seeds of forage legumes and tame and native grasses, forage, potatoes, sugar beets and a variety of horticultural crops.

In 1967 it was said that farmers annually planted approximately 3 1/4 million acres of corn, 3 million of oats, 2 3/4 of wheat (2 million HRS, 700,000 HRW and 100,000 durum), 600,000 acres of flax, 500,000 of barley, 200,000 to 300,000 each of rye, soybeans and sorghum, 8,000 of potatoes and 5,000 of sugar beets. In addition, about 5 million acres were used for hay (2 1/2 million wild hay, 2 of alfalfa and 500,000 of tame grass hay), 100,000 for forage seed production, and 25 million acres were devoted to pasture and rangeland.

Cline and Sanderson, with some assistance from Derscheid, conducted the crop improvement and production programs. They recommended the use of adapted disease-resistant varieties of adapted crops, high quality seed, seed treatment, soil sanitation, weed control and insect control.

Sugar Beets and Their Replacement.

In 1960 the U and I Sugar Co. decided to contract for sugar beets in eastern South Dakota. Production on the irrigation projects near Belle Fourche and Hot Springs fluctuated from 2,000 to 8,000 acres and a more stable and larger supply was desired for the refinery in Belle Fourche.

Extension agronomists supervised several subject matter meetings, prepared a special fact sheet, wrote news stories and were interviewed on radio programs about sugar beet production.

In 1961 about 2,000 acres of beets were planted in northern Beadle and southern Spink counties and about 2,200 acres were raised in Turner County, which doubled the 1960 acreage.

By 1964, 12,000 to 13,000 acres were produced in the state, but the refinery closed at the end of the season. Agronomists were then faced with the problem of suggesting crops that could be grown on the 5,000 acres of the Belle Fourche Irrigation project previously devoted to sugar beets. Agronomists encouraged an expansion of the present acreage of corn, alfalfa and irrigated pastures, and encouraged farmers to plant a western 2-row malting barley and dry field beans so its potential as a high income cash crop could be better evaluated.

The variety Firlbecks III, a 2-row malting variety, was chosen for this evaluation planting because of its kernel size, test weight, straw strength and yielding potential when irrigated. Through the cooperative efforts of the Northwestern Malt and Grain Company, 500 bushels of high quality seed were obtained from California and planted on 245 acres of 13 farms in 1967.

In February 1968 a meeting with growers and representatives of the Experiment Station, Extension Service and Malting and Grain Buyers was held in Belle Fourche. The meeting was held to give growers, grain buyers and maltsters an opportunity to relate their experiences and problems encountered with the 1967 crop, to hear reports on crop performance and quality tests, to learn production practices for obtaining maximum yields and to decide whether to pursue the program for another year.

In 1968, 75 farmers planted approximately 800 acres. Approximately 10 car loads were shipped to the grain trade--most had acceptable protein, graded No. 1 Choice, and brought about \$50.00 a ton.

The program stimulated great interest it was expected that more growers would raise the crop in the future.

Edible field beans also appeared to have potential as a cash crop for use on some of the acres formerly used for sugar beet production. Pinto, Great Northern and navy beans were planted in several variety demonstrations with seed obtained from Idaho and Nebraska on the Belle Fourche and Angostora irrigation projects (Cline).

There was no local market for the beans and several meetings of prospective growers and commercial buyers from Nebraska and Wyoming were held in an attempt to solve the problem. It appeared that the establishment of a local receiving station was essential--a place where the beans could be cleaned and eliminate the cost of transporting the "tare" to the nearest market in Torrington, Wyoming (Cline).

The acreage of beans expanded for a period, but the lack of a nearby outlet caused the project to fail (Cline).

Crop Quality

Efforts to improve the quality of malting barley and milling oats continued. Barley acreage declined during the early 1960s, partly because of the Feed Grain program of 1963. Maltsters and brewers were concerned. Therefore, in 1966, Extension agronomists and the Barley Improvement Association sponsored farmer meetings in the northeastern counties. Sanderson, Derscheid, USDA barley breeder P. B. Price, and representatives from the malting and brewing industry and the Milwaukee Railroad presented information on production, harvesting, storage and shipping in order to produce barley with a maximum of 13.5% protein and 13.5% moisture, at least 65% plump kernels and a minimum of skinned and broken kernels.

In previous years, 50% (70% at one station) of the barley was discounted because of too many skinned and broken kernels. This was reduced to 10% in 1966.

Sanderson also cooperated with Quaker Oats Co. in an effort to secure high protein, high test weight, white oats with less than 1% barley for milling.

In 1962 50% of the oat crop was discounted 2 to 3 cents per bushel because it contained more than 1% barley. Only 6% on the 2013 carloads of oats that had reached the Sioux City market were discounted during the first half of 1966.

Both programs were continued. As a result, South Dakota annually ranked second or third among the states for malting barley production and among the top four, usually second or third, for milling oats production.

Variety Demonstrations

In 1961 Cline and Sanderson assisted in organizing 193 small grain and flax demonstration plots (38 HRS wheat, 29 durum, 10 HRW wheat, 45 oats, 45 barley, 25 flax and 1 rye) in 40 counties.

Plots continued to be sponsored by the county crop improvement association with and under the supervision of the county agents. Extension agronomists continued to provide seed, variety descriptions, report blanks for taking notes and sacks for yield samples; and they threshed the samples.

These demonstrations kept farmers informed about adapted varieties. More than 88% of the wheat acreage, 95% of the flax, 86% of barley and about 75% of oats acreage were planted to varieties recommended by the crop breeders and Extension agronomists.

Also in 1961, assistance was given in the organization of 14 corn hybrid and 13 soybean, 25 grain sorghum and 23 forage sorghum variety demonstration plots.

Seed samples of 20 grass and legume varieties were provided in 1961 to county extension agents, SCS personnel and vocational agricultural instructors so they could raise plant materials for use in studying forage crops.

As a result of the variety demonstrations, most farmers grew recommended varieties of small grain. In 1965 the South Dakota Crop and Livestock Reporting Service reported that 97% of the barley acreage was planted to recommended varieties. Three years later a Wheat Quality Council survey showed that 90%

of the wheat varieties being grown in South Dakota were recommended varieties. For other small grain crops, flax and soybeans, this figure was also 90% or above.



Excellent flax variety demonstration.

Forty counties in 1968 conducted 170 crop variety demonstration plots--47 oats, 47 barley, 42 HRS wheat, 29 durum wheat, 24 HRW wheat, 23 flax, 13 grain sorghum, 11 forage sorghum, 8 corn, 7 soybean, 7 rye, 2 dry field beans and 2 commercial sunflowers.

With the expanded Variety Performance Test Program and the planting of variety demonstrations on outlying research stations, the number of county demonstrations began to decline. Several southeast counties, for example, held an area tour of crop variety and weed control plots at the Southeast Experiment Farm. Pennington, Walworth and Perkins counties used nearby Crop Performance tests for the variety tours. Codington, Hyde, Haakon and others used the demonstration plots at Watertown, Highmore and Cottonwood, respectively.

The large number of commercial corn hybrids, sorghum hybrids and soybean varieties made it impossible to plant all of them. Variety demonstrations were discontinued for corn and sorghum during the late 1960s and for soybeans in the early 1970s.

When Reid became Extension crops specialist in 1975, he decided to discontinue the practice of threshing yield samples from small grain plots. More counties discontinued them. In 1980, 20 counties had plots of spring grains and 8 had winter grain demonstrations.

Other Crops Demonstrations

Derscheid developed a crop production demonstration in the early 1960s in which several plots of corn or a small grain were planted. Each plot received a different treatment with fertilizer, herbicide, tillage or a combination of two or more of these treatments. One plot received no fertilizer

or herbicide while another received the best combination of fertilizer, chemical and tillage. Minnehaha County conducted one or two demonstrations for a year or so and Davison County conducted a corn demonstration for several years, but in general it was too difficult to include so many treatments and the demonstration was soon discontinued.

"Every Crop Improver a Demonstrator" was Sanderson's idea. With the assistance of Langin, he encouraged all crop improvement members to get a soil test of at least one field and apply the recommended amount of fertilizer on part of the field to demonstrate to themselves and their neighbors that fertilizer would increase yields under normal conditions.

One Miner County farmer didn't like the program. He fertilized a strip in the middle of a small grain field, and the fertilized grain grew taller. While going around the field during harvest, he had to raise the cutter bar whenever he came to the fertilized strip and lower it when he left the strip. This happened on each end of the field and stopping to adjust the cutter bar height four times each round was too much trouble.

The program was replaced in 1967 by the "Yield Explorer Club". It was initiated as a special project for county crop improvement associations to sponsor in their respective counties. All counties received a supply of explanatory information, yield goals of various crops for each county and yield achievement forms to record practices used in attaining the high yields.

All producers attaining the designated yield received a certificate signifying him as a member of the Yield Explorer Club. A special framed certificate was awarded to the operator getting the highest yield of a crop within each of the eight crop improvement districts. A special plaque was given to the producer having the outstanding production performance within each SDCIA District.

All recognitions were made at the State Crop Improvement Annual Meeting. Participants qualifying for membership in the group were guests of the sponsoring organizations at the meeting where they received their awards.

In 1967, 27 producers attained yields qualifying them as members. In 1968, 46 achievement record forms were submitted by 20 counties--32 producers qualified for membership.

Quality of Seed and Crop

Extension crops specialists had always recommended the use of high quality seed. During the 1960s, they started to recommend that

a producer plant one-half of his small grain and flax acreage to Certified seed every third year. Seed produced would furnish a supply of good quality seed for all the acreage the next 2 years and half the acreage the third year.

Close cooperation with the SDCIA, South Dakota Seed Trade Association and Agricultural Experiment Station resulted in a change in seed certification procedure to stimulate production of certified seed. The 1966 acreage exceeded the 1965 acreage by 10,090 acres and producers were having more success in selling it. This program continued to the present date.

Soil Fertility

By 1961 the soils in South Dakota had lost an average of 40% of the original organic matter including, 35% of its nitrogen and 15% of its phosphorus. This resulted in a break down of soil structure and reduced water absorption and retention. The fertility problem was acute in eastern counties.

Davis, followed by Langin and Adams, recommended the use of crop residue, barnyard manure, grasses and legumes in the rotation, and commercial fertilizer to maintain or regain high soil fertility where a soil test indicated the need.

Interest in the use of commercial fertilizer increased significantly during the early 1960s, and the amount of fertilizer actually used was increasing. In 1965 an estimated 250 crop improvement members conducted their own fertilizer demonstrations--half of them obtained soil tests before applying fertilizer on the treated portion of the demonstration. The amount of fertilizer sold increased from 51,000 tons in 1961 to 160,000 in 1966. Fertilizer was applied to about 3,000 acres of corn, 2,400 of oats, 2,000 of alfalfa, 1,600 of spring wheat, 600 of tame grass, 500 of sorghum, 400 of winter wheat and 300 acres of barley.

Increased fertilizer use was accompanied by an increased interest in soil testing--8,617 samples tested in 1965 and 11,688 samples in 1966. The *Farmer Magazine* sponsored a county award for soil testing. In 1965, 46% of the farmers in the winning county had their soil tested. Walworth won in 1966 with 57.4% participation.

A zinc survey was made in 1966, in cooperation with TVA and Farmers Union Central Exchange, to delineate zinc deficient soils in the state.

During the 1970s Extension soils specialists continued the programs already instituted. Considerable effort was devoted to encourage far-

mers to use soil tests in order to determine the correct amount of fertilizer. The number of tests conducted by the Soils Testing Laboratory (see Chapter XXVIII) rose from 2,200 in 1950 to 10,000-12,000 during the mid-1960s, when the ASCS required soil tests before it would make cost-share payments for ACP programs, and almost 14,000 in 1980.

Fertilizer Demonstrations

The TVA test demonstration program initiated by Ladd in 1950 was conducted annually for the next 30 years. In 1961 it included 45 cooperators in 17 counties. Five counties completed the program in 1961, and 12 were added for a total of 52 cooperators in 23 counties in 1962.

A total of 436 tons of fertilizer, a 33% increase over 1960, was used in the 1961 demonstrations. The fertilizers included ammonium nitrate, ammonium nitrate sulfate, ammonium phosphate nitrate, concentrated superphosphate, calcium metaphosphate, diammonium phosphate, and leached zone fertilizers.

Fertilizer dealer result demonstrations were conducted by Extension at 66 locations in 19 counties in 1961 to demonstrate the use of fertilizer on most agronomic crops under numerous soils and climatic conditions. Yields were increased considerably on grass, corn and small grain, and protein content was increased by higher rates of nitrogen.

Result demonstrations to compare broadcast application of phosphate with the placement of fertilizer along with the seed was conducted at 18 locations in 12 counties in 1961. Yield of wheat was increased 2 to 3 bushels per acre and barley 8 to 12 bushels by placing the fertilizer with the seed.

When Langin left a soils research position in 1963 to become an Extension specialist, the research position was discontinued. After that, the research program was closely tied to the TVA programs conducted in succession by Langin, Adams and Schoper. Paul Carson, head of the soil fertility research project, said: "Without their help little would have been accomplished with the research field trials."

Langin, in 1966, devoted full-time to the TVA demonstration program--half-time on the test demonstrations and half-time on dealer demonstrations. In the test demonstrations, 41 cooperators in 19 counties applied 300 tons of TVA fertilizer. In the dealer demonstration program, five cooperators in Fall River County applied nitrogen on irrigated corn at rates of 60, 120 and 180 pounds of N per acre. Yields were obtained and soil nitrates measured to determine the most economical rate

of N and to observe nitrogen behavior on the soil.

Also in 1966, nitrogen, phosphorus, potassium and zinc were applied to dry edible beans under irrigation at Angostora and Newell to determine if any of the elements were needed by the crop. Results were negative.

Under the TVA program 60 field-size fertilizer demonstrations were established in 1967 on different crops by 18 farmer cooperators in Deuel County. The demonstrations were used for tours and as examples of how crops responded to different fertilizer programs. By the end of 1968 some operators felt that they could profitably use nitrogen rates somewhat in excess of those recommended for average conditions. Plans were made to continue the program for three more years.

Through the support of TVA and Farmland Industries, 64 different demonstrations on the use of nitrogen on corn were established in eastern counties. In addition to yield and protein determinations, soil nitrate levels, plant analysis, rainfall records, soil test levels, and other observations and tests were made.

Assistance was given to research staff on a program in 1968 to help evaluate new fertilizer material. This involved an evaluation of ortho, nitric, and poly forms of phosphate on small grains, a comparison of liquid and dry forms of fertilizer on small grains and the use of micro-nutrients on small grain.

Results indicated that the three forms of phosphorus were equally well adapted to South Dakota, the liquid and dry forms gave equal yield increases and that there was no significant yield response to any of the micro-nutrients tested.

Yield results with nitrogen on corn were variable, but the nitrogen recommendation made by the Soil Testing Laboratory proved to be among the most profitable rates in most cases. This was extremely important to South Dakota farmers because fertilizer dealers frequently accused the laboratory of recommending less fertilizer than was needed and urged farmers to use much higher rates. These demonstrations indicated that higher rates were not always profitable. In fact, actual decline in profit and increased pollution in some soils could make higher rates unwarranted.

Fertilizer Use

The Extension soils program emphasized a balanced soil fertility program. However, as years passed and soil fertility declined, they recommended the use of more and more fertili-

zer. According to South Dakota Department of Agriculture figures, the amount of fertilizer sold in the state gradually increased from 31,000 tons in 1954 to 447,000 tons in 1979.

Thousands of tons of fertilizer
sold in South Dakota.

Year	Tons 000	Year	Tons 000
1954	31	1969	267
1956	24	1970	292
1958	36	1971	321
1960	37	1972	301
1961	51	1973	434
1962	67	1974	356
1963	85	1975	330
1964	107	1976	350
1965	120	1977	359
1966	175	1978	375
1967	220	1979	447
1968	234		

Soil and Water Conservation

The deterioration of soil structure resulted in reduced water absorption and retention and accelerated erosion and runoff. All land with over a 3% slope was subject to water erosion and thousands of acres were subject to wind erosion.

Williamson supervised this program except for a 5-year period. Davis was in charge for one year and Adams for 4 years. They continued to organize soil and water conservation districts and promote the use of crop residue management, strip cropping, contouring, planting of grass on slopes and drainage ways and watershed development to reduce soil erosion and conserve moisture.

Molan, the southeast township of Hutchinson County, became a soil and water conservation district in 1961. All the counties in the state except Douglas, Faulk and the remainder of Hutchinson County were organized into districts. The 68 districts included approximately 95% of the farmland in the state and had established adequate conservation treatments on 40% of cropland and 38% of the rangeland.

During 1959, 1960, and 1961, 39 stubble mulch demonstrations had been held in most of the counties receiving less than 20 inches of average annual precipitation. During the 3-year period, the use of blade and multi-blade equipment increased 10 to 15% giving better mulch management than had been obtained with the one-way disk and plow.

The Great Plains Conservation Program in 1961 was established in the 35th of the 39 counties within the Great Plains boundary (western 2/3 of the state). There were 320 contracts with farmers and ranchers covering an area of 1,275,255 acres. Douglas, Faulk, Edmunds and Lawrence counties had not yet started to participate in the program.

The residue management tillage demonstrations, initiated by Ladd, were continued annually. Williamson in 1968 conducted five demonstrations in cooperation with the SCS, ASCS and farm machinery dealers. Information on recent research findings in residue management (stubble mulch farming) were reviewed and various equipment displayed and demonstrated.



Noble blade at stubble mulch demonstration.

Installation of a 10-year soil erosion and runoff demonstration was initiated at the West Prairie Coteau Research Farm near Garden City in 1968 with funds provided by the 11 conservation districts of Northeast South Dakota.

A 5-year rotation of corn-oats-alfalfa-alfalfa-alfalfa was planted up and down the 5% slope, and a 2-year rotation of corn-oats was planted in both directions--up and down and across the slope. Catch basins were constructed to measure differences in run-off and soil erosion (see Chapter XXII). The demonstration was discontinued in 1973 when the farm was closed.

For 4 years beginning in 1974 Williamson and G. R. Durland, Extension machinery specialist, compared three tillage systems for corn production in the farm of Duane Ellis at Elkton. The conventional tillage system included plowing, disking, harrowing and row-crop cultivation; the reduced tillage system substituted the chisel for the moldboard plow; and no tillage included the use of a no-till planter with no seed-bed preparation. Records were kept on yield, machinery costs and fuel consumption. Gallons of gasoline were 560, 455 and 288 gallons per acre for the three

systems, and machinery costs were \$873, \$731 and \$156 per acre. At \$2 per bushel corn yields of 43.7, 36.6 and 27.0 bushels per acre were required to pay for production costs.

During the 1970s Williamson continued to meet with the Conservation Commission, the Association of Conservation District Supervisors, assist the SCS with the Great Plains Conservation Program and conduct residue management demonstrations.

Pastures

Though pasture management was included in the plan of work for years, little was done. Norgaard assisted with a pasture contest in the early 1940s, Cline organized a pasture demonstration in 1951 and a 3-year interdisciplinary pasture program was launched in 1958.

The first demonstration was conducted in 1951 at Ipswich. It was a pasture renovation demonstration in which part of an abused pasture was disked to prepare a seedbed for new seedings. Smooth brome grass and crested wheatgrass were seeded alone and in mixtures with alfalfa. Several fertilizer treatments were imposed on the various seedings to demonstrate the value of fertilizer for stand establishment.

In 1961 Cline cooperated with the county agent and range management specialists in the Animal Husbandry Department and SCS to establish a pasture demonstration in Perkins County. An 84-acre pasture was seeded to a grass-legume mixture, and a 20-acre crested wheatgrass pasture was renovated in two ways--10 acres with various amounts of fertilizer and 10 acres tilled and fertilized with the same rates. A 300-acre native range was sprayed with 2,4-D to control fringed sagewort. Plans were made to plant a shelterbelt in 1962.

Four district range evaluation and management schools were held to teach county agents, ranchers and youth how to identify range plants, evaluate range condition and how to bring range back to excellent condition.

At the Northern Seedsmen Association Meeting in 1962, Extension agronomists from Minnesota, North Dakota and South Dakota estimated that an additional 6,940,000 pounds of 2,4-D or MCPA--1.8 million in Minnesota, 1.9 in North Dakota and 3.2 million in South Dakota--could profitably be used to control weeds in grasslands in the three states.

The Dow Chemical Company volunteered to furnish the 2,4-D needed to spray large 3-year demonstrations. A number of demonstrations were initiated in North Dakota in 1963.

During 1964, 17 demonstrations were conducted in 13 South Dakota counties. Two locations in another county were added in 1965, and some of those started in 1964 were discontinued. Dow furnished enough 2,4-D ester for 40 acres at each location. Derscheid prepared a demonstration plan and clipped yield samples from each plot each month, June to September, inclusive. The county agents and farmer cooperators applied herbicide and fertilizer and erected exclosures. The following treatments were made.

- Treatment 1. No fertilizer, no 2,4-D on about 1/6 of the pasture.
- Treatment 2. Application of nitrogen fertilizer without 2,4-D on a 1-acre plot in the corner of plot 1.
- Treatment 3. Low rate of 2,4-D-(the amount recommended for control of the predominant weed) on about 2/3 of the pasture.
- Treatment 4. Low rate of 2,4-D with addition of nitrogen fertilizer on a 1-acre plot in the corner of plot 3.
- Treatment 5. High rate of 2,4-D (double the recommended rate) on about 1/6 of the pasture.
- Treatment 6. High rate of 2,4-D with addition of nitrogen fertilizer on a 1-acre plot in the corner of plot 5.

On overgrazed Kentucky bluegrass pastures, forage yields were increased enough in one year from weed control to more than pay for the cost of spraying. During the dry year of 1964, fertilizer increased forage yields, but not enough to pay for the fertilizer. It also increased spring growth of some weeds on unsprayed plots to the extent that grass yield was reduced in July. Fertilizer applied to two demonstrations for the first time in 1965, a year of greater rainfall, and carry over from nitrogen applied to other demonstrations in 1964 increased grass yields enough by the end of 1965 to pay for the fertilizer. There was no carry-over effect in 1966.

In 1965 Derscheid provided seed of several pasture mixtures for five county demonstrations to show when each pasture mixture should be grazed in various parts of the state. A mixture of Nordan crested wheatgrass and Teton alfalfa was used for early spring grazing; a mixture of Oahe intermediate wheatgrass, smooth brome grass and Teton alfalfa was used for late spring and early summer; a mixture of

Summer switchgrass, big bluestem and yellow Indiangrass was used for mid-summer and a mixture of crested wheatgrass and Vinall Russian wildrye was used for late fall grazing.

Yields were correlated with yields from similar pastures at the Pasture Research Center in order to estimate the carrying capacity for each mixture in various parts of the state.

Also in 1965 the ASCS program included cost sharing for the planting of pastures under the Crop Conversion Program in four counties and a special ACP practice in two others. Farmers in these counties were encouraged to plant several pasture mixtures and graze them rotationally. A mixture of crested wheatgrass and pasture-type alfalfa was suggested for those who wished to start grazing before May 20. A mixture of smooth brome grass, intermediate wheatgrass and pasture-type alfalfa was suggested for the main pasture to be grazed between May 20 and July 10 and again between August 20 and September 20. Sudan grass or a warm-season perennial grass pasture was suggested for late July and early August and either crested wheatgrass or Russian wildrye was recommended for grazing after mid-September.

The value of pasture rotation was being recognized by many livestock producers. A farmer near Beresford, for example, tried it in 1965 with 85 heifers on three pastures totaling 37 acres. He increased the size of the herd to 106 in 1966 and still had hay to cut. Another farmer in Spink County rotated 200 cows and calves on a quarter section and a farmer in Grant County rotated dairy cattle every 1 to 3 days on 15 paddocks. A farmer in Marshall County rotated 300 head of yearlings on 340 acres. He started May 1 with 26 acres of Russian wild rye. He then moved to four pastures May 15--established brome grass-alfalfa pastures of 57- and 69-acres in size and two 60-acre pastures seeded in 1965 with brome grass, intermediate wheatgrass and alfalfa. He supplemented these pastures in July and August with a 33-acre pasture of warm-season grasses and a 38-acre native pasture. He also rotated 100 head of yearlings on 60 acres of a brome grass-alfalfa mixture supplemented with 10 acres of sudangrass.

Two farmers each in Day and Aurora counties planted pastures for a 6- to 7-month season; one in Day and three in Aurora planted for the period between mid-May and mid-September. Tours were held on their farms to demonstrate their pasture systems.

By 1966 interest in the use of more productive pasture mixtures and management and the use of fertilization, weed control and inter-

seeding for improving pastures had increased considerably. An SDSU interseeder was used in several counties to interseed 50-acre demonstration pastures and to demonstrate the type of machine needed. Campbell County farmers were ready to interseed 2 to 3 thousand acres and Day County farmers would have kept a machine busy for 2 to 3 weeks.

Groups of 10 to 20 farmers that had attended pasture meetings in 1964 had increased to crowds. In Clark County, for example, 26 attended a meeting in 1964, but 145 attended 2 years later. One demonstration conducted in Corson County was attended by 120 in that sparsely populated area. Likewise, a group of over 80 farmers from Aurora, Davison and Douglas counties attended a series of four pasture improvement meetings.

Interest in interseeding started in Sanborn County in 1964 and spread to Aurora, Day, Faulk, Marshall and Campbell in 1966 to Hand, Hyde, Sully, Codington, Grant, Miner, Brule, Perkins, Lyman, Spink and Walworth in 1967 and to Beadle, Bennett, Brown, Deuel, Dewey, Gregory, Harding, Hughes and Tripp in 1968. Equipment was not yet available to do all the interseeding that farmers wanted to do. An SDSU interseeder was used to interseed 40- to 80-acre demonstrations in 1967 and 1968. The value of interseeding and equipment needed for interseeding were demonstrated. Farmers gladly paid for the cost of interseeding because it was the only way that they could get it done.

In some counties, individuals secured equipment and did interseeding on a custom basis. In other counties, implement or seed companies had drills for rent and in others, county organizations secured equipment for use on a rental basis. Almost 10,000 acres were interseeded--Aurora 160, Beadle 400, Bennett 1400, Brown 180, Brule 300, Campbell 20, Deuel 300, Dewey 30, Faulk 735, Grant 160, Gregory 1,000, Harding 2,000, Hughes 500, Lyman, 1,000 Miner 525, Sully 750, Tripp 290 and Walworth 180.

Derscheid developed a shortcourse in 1968 on pasture establishment, improvement and management. It was presented in three sessions spaced one week apart at 16 locations, representing 21 counties and two Indian reservations. The first and third lessons were presented by Derscheid and the second by local personnel with the host county agent being in charge.

The first lesson covered methods of improving existing pastures where it was impractical to seed more productive species in a pasture renovation program. Such topics as interseeding, fertilization, weed control and their interrelationship was discussed in detail. The use of adapted species on lowlands and

alkaline areas, deferred grazing, chiseling, pitting and pasture furrowing was discussed in less detail. Fact sheets on interseeding and fertilization were revised and a new fact sheet on weed control was written and distributed at the time the lesson was presented.

For the second lesson, Derscheid prepared a slide series with a script on the topic of stand establishment. A 17-minute colored film narrated by pasture researcher R. A. Moore who discussed growth habits, season of growth, productivity and adaptation of the most important pasture crops (species and varieties) was also prepared. The county agents from the counties represented attended a meeting in Huron where the slide series and the film were discussed in detail. A system was devised for the county agents to rotate the slides and the film from one to another. Slides that were shown in lessons 1 and 3 were also shown and discussed in less detail, and plans were made for the host agents to order the literature needed and to prepare a booklet containing the material.

Bundles of mature grass and packets of seed for ten grass species were prepared for use as visual aids for the meetings. Mimeographs "Grass Variety Descriptions" by grass breeder J. G. Ross and "Legume Variety Descriptions" by alfalfa breeder M. D. Rumbaugh and fact sheets entitled "Pure Live Seed", "Range Seedings", "Planting Tame Pastures and Haylands", "Native Grasses for Pasture and Hay" and "Tame Grasses for Pasture and Hay" were distributed to those attending the session.

Lesson 3 was presented by Derscheid. He discussed the topics of "How Grasses Grow", pasture mixtures, seasonal pastures and "Graze Green Grass for Greater Gains". Fact sheets entitled "Grazing Management Based on How Grasses Grow", "A Pasture System for You", "Proper Range Use" and "Graze Longer and Feed Less Roughage", were distributed at this meeting. A portable exhibit entitled "Graze Growing Grass for Greatest Gains" was displayed during this lesson.

The shortcourse was presented at nine locations the last 3 weeks in January and at seven locations the first 3 weeks in February of 1969.

Almost 700 farmers attended the 3-session pasture shortcourse--58 at Howard, 33 at Letcher, 33 at Forestburg, 34 at Plankinton, 61 at Platte, 38 at Chamberlain, 18 at Blunt, 27 at Gettysburg, 20 at Selby, 54 at Eureka, 94 at Brookings, 44 at DeSmet, 54 at Huron, 33 at Miller, 23 at Highmore, 46 at Ipswich and 58 at Redfield.

The pasture shortcourse was presented in about 10 counties during 1970 and a few more in 1971, covering nearly all of East River.

Farmers became convinced that the use of fertilizer and weed control increased pasture production more than enough to pay for the cost. Increased interest in the use of fertilizer was apparent in Marshall, Corson, Beadle, Kingsbury, Miner, Charles Mix, Brule, Spink, Edmunds and Walworth counties with usage up 40% in Brown and 300 to 400% in Spink. Increased interest in weed control was manifested in Marshall, Miner, Brule, Aurora and Edmunds counties. ACP payments of \$10,000 were made for spraying 12,775 acres of gumweed in Beadle County and 3,000 acres of buckbrush and other pasture weeds in Moody county. In Hamlin County 10% of the pastures were completely sprayed and 30% of them were partially sprayed; and in 1968 several thousands of acres of goldenrod were sprayed in Codington County.

The use of a good pasture mixture was of interest in Hamlin, Butte, Brule, Deuel, Aurora, Kingsbury and Edmunds counties. Two county-owned drills in Edmunds seeded 3,245 acres the spring of 1967 and around 2,000 in the fall. The county was considering the purchase of a third drill. Kingsbury was also thinking about buying a drill. Lyman County was interested in the use of sorghum hybrids for winter pasture.

Then the format was changed to a 4-hour session. Topics included (1) pasture crops and species by J. G. Ross or C. R. Krueger, pasture researcher; (2) "How Grasses Grow", seasonal pastures and "Graze Green Grass for Greater Gains" by Derscheid; (3) stand establishment and special management practices by Krueger; and (4) improving "worn out pastures" with interseeding, weed control and fertilization by Derscheid.

During that period, "Graze Green Grass for Greater Gains" was stressed. This program advocated use of crested wheatgrass and a pasture-type alfalfa for 5 weeks of grazing in late April and early May; a mixture of bromegrass, intermediate wheatgrasses and alfalfa (BIA) for 7 weeks between May 20 and July 10; switchgrass for 5 weeks in July and early August; BIA for a month in August and September; and Russian wildrye for 7 weeks after mid-September.

Research data from the Pasture Research Center in Faulk County showed that best gains and highest carrying capacity were obtained from such a system, but an economic analysis indicated that costs of production were so high that it was not the most profitable system.

Therefore, Derscheid began the "Alternative Pasture and Forage Systems" program which included a discussion of grass management. The 6 1/2-month grazing season was divided into five 1-month to 6 1/2-week periods. The cost per animal unit for native pasture, tame pasture and harvested forage was estimated for each period for each of six grazing areas in the state. In a 2-hour session he illustrated the differences in costs for each period and compared costs of a half dozen combinations of forage and pasture for the entire 6 1/2-month grazing season for the area in which the topic was discussed.

At the same time there was growing interest for the use of oats as forage. Small grains were better adapted to many parts of South Dakota than long-season crops. Small grains could generally be produced with seasonal rainfall. Long-season crops relied on subsoil moisture or required precipitation in July and August, but normal rainfall in most parts of the state was not sufficient during these months to produce a good long-season crop.

Derscheid reviewed all the data, pertaining to the production and feeding of small grains and other annual crops for forage that had been obtained by the Agronomy, Animal Science and Dairy Departments in the previous 20 years. The data indicated that oats produced as much forage as long-season crops in central South Dakota, but not in eastern South Dakota. However, oats produced protein cheaper than any crop except alfalfa, and it produced energy (TDN) and dry matter at lower cost than any other crop in much of the state. Oats forage was generally higher in protein, but lower in energy than corn silage.

Therefore, Derscheid conducted a program on the use of small grains for forage. His fact sheet and 45-minute program were best adapted for the area north and west of a line drawn from Clear Lake to Lake Andes.

Derscheid and Williamson initiated a 2-year result demonstration in 1973 on the use of fertilizer and rotation grazing on the Bones Ranch near Parker. One 75-acre bromegrass pasture was stocked with 30 Hereford cow-calf pairs. A similar pasture on the same quarter section was cross-fenced to form two smaller pastures, tested for soil fertility and fertilized with nitrogen. A dugout was constructed to provide water in one of the smaller pastures and 40 cow-calf pairs were rotated between the two pastures every 3 weeks. Fertilizer response was minimal due to lack of rainfall, but more animal days of grazing were obtained and cows and calves gained more weight. With normal cattle prices, the increased beef production did not pay for the fertilizer and extra man hours

even though the fertilizer was provided at a reduced price by TVA. However, cattle prices soared during the fall and the use of fertilizer and rotation grazing proved to be profitable.

At the same time 205 Hereford yearling heifers were rotated between two 80-acre fertilized pastures composed of brome grass and some alfalfa. When compared with a smaller number of heifers on a smaller nearby pasture with somewhat higher fertility, the results were essentially the same as with the cow-calf pairs.

Noxious Weeds

The State Weed Law and State Weed Commission were concerned only with the eight deep-rooted perennials designated as noxious. These weeds caused crop yield reductions from 1/3 to total loss. Because they spread from farm to farm, they were a community problem. Early eradication of small infestations (weed nurseries) was the most effective and the cheapest means of combating the threat to crop production.

During 1960 field bindweed infested all or parts of 28,527 farms (1,112,156 acres), Canada thistle 21,096 farms (1,021,096 acres), perennial sowthistle 13,788 farms (155,788 acres), quackgrass 13,915 farms (175,221 acres), leafy spurge 4,508 farms (32,284 acres), hoary cress 313 farms (754 acres), Russian knapweed 280 farms (434 acres) and horse nettle infested 104 farms (762 acres), for a total of almost 2 1/2 million acres on 82,531 farms.

County reports in 1960 indicated that control measures were being applied on 76% of the farms having one or more noxious weeds. For individual species the percentages were 86 for bindweed, 81 for leafy spurge, 75 for hoary cress, 68 for Russian knapweed, 43 for horse nettle, and 79 for quackgrass.

Wallace conducted the program, followed by Frost, Parker and Wrage, with some assistance from Derscheid. They advocated the use of clean seed, proper crop rotation and good soil management to prevent infestation; soil sterilants to eliminate weed nurseries; a combination of competitive crops, cultivation and chemicals to eliminate large infestations and an annual application of 2,4-D to prevent re-infestation.

Derscheid wrote the F-2 Weed Control Practice for the ACP program under which the ASCS paid half the cost of controlling noxious weeds. In 1961, about 90,000 acres of noxious weeds were being controlled under that practice.

In 1961 Wallace distributed seven soil sterilant kits to six counties to demonstrate the use of soil sterilants for eliminating "weed nurseries".

Wallace and Derscheid held meetings with state and county highway personnel where they discussed chemicals and demonstrated the use of chemicals and sprayers for noxious weed control on rights-of-way. In 1961 county highway departments spent over \$10,000 to control noxious weeds on county roads.

Kenneth R. Frost, Jr., succeeded Wallace as Extension Agronomist-Weeds in September 1961.

By 1962, 52 counties reported 1,595,757 acres of noxious weeds on 39,791 farms and that weed control practices were being applied to 82% of the farms. If the other 14 counties in the state had the same type of noxious weed infestation, there could have been about 2 million acres infested with the weeds--a 20% reduction since 1960. Fifty counties reported fewer acres of field bindweed, quackgrass, Canada thistle, leafy spurge, Russian knapweed, hoary cress and horse nettle; but more acres of perennial sowthistle.

In 1968 2 1/2 million acres were infested with noxious weeds, 5 million were infested with wild oats (a secondary noxious weed) and almost a half million acres in 14 counties were infested with five weeds designated as "locally noxious."

With the two counties organized in 1968, 63 counties had organized weed boards--62 were active enough to qualify for ACP cost sharing.

Three more weeds were designated as locally noxious in three counties, bringing the total to eight locally noxious weeds in 25 counties (two per county).

Two years later Frost started to work closely with the U.S. Forest Service, landowners and county personnel to develop a program for the control of Canada thistle in the Black Hills. He conducted treatment demonstrations on Canada thistle at several locations and big sagebrush near Custer. He concluded one of the statewide weed tours with a spraying demonstration. Weeds were sprayed in a remote area of the Black Hills Forest with a helicopter brought in from Worland, Wyoming.

Frost made numerous applications of soil sterilant chemicals to control perennial weeds in grasses in various non-cropland situations--around lights along airport runways, around signs on highways, in implement dealers machinery yards, along fence lines and others.

Parker, in 1968 and 1969, provided chemicals for county demonstrations to show the value of non-selective herbicides for patch control and the use of combinations of herbicides with cultural practices to control large infestations of noxious weeds while growing crops adapted to the area. He encouraged farmers to use the ACP cost-sharing program which paid half the cost of the above practices for control of noxious and locally noxious weeds.

He continued to attend county meetings and conduct weed clinics for commercial applicators, herbicide retail dealers and county weed personnel.

Parker left South Dakota in 1969 to enroll in graduate school at Utah State University. Leon J. Wrage returned in October to his home state to be the sixth Extension weed specialist.

In 1972 Wrage and Derscheid reactivated the training schools for state highway personnel. They encouraged the use of non-selective chemicals to control patches of noxious weeds on the rights-of-way of one-fourth of the road system each year. They predicted better weed control, less damage to nearby susceptible crops from drift and no increase in costs over the system of spraying all the rights-of-way with 2,4-D every year.

They also activated the weed supervisors school.

Annual Weeds

Annual weeds often utilized more moisture and plant food than crops. Because they were more widespread than noxious weeds, they caused more than half of the \$50 million annual loss caused by weeds.

Wallace prepared materials and directions in 1961 for annual weed control demonstrations in 14 counties. The chemicals were to be applied pre-emergence for weed control in corn, soybeans and post-emergence in new seedings of alfalfa.

Wallace, in cooperation with the Extension forester in 1961, provided chemicals and directions for their use in 30 county demonstrations of weed control in shelterbelts in 11 counties.

Though chemicals were considered as an additional tool and not a substitute for clean seed, good cultural practices, high fertility and crop rotation for controlling weeds, over 3 million acres of cropland were sprayed with 2,4-D in 1961.

In 1962 it was estimated that wild oats, sunflowers, cockleburrs, mustards and foxtails each infested about 5 million acres. Of course, two or more species infested the same acreage. About 3 3/4 million acres were sprayed with 2,4-D to control broadleaved weeds, including noxious weeds.

During his 4-year tenure, Frost conducted numerous demonstrations on the use of pre-emergence herbicides in row crops. In one demonstration in Aurora County, he mixed atrazine in fuel oil and applied it post-emergence in grain sorghum. No one had any idea that it would be effective because atrazine had always been mixed in water and applied pre-emergence, but it damaged sorghum when applied in that manner. The treatment controlled the annual broadleaved and some of the grassy weeds without hurting the sorghum. The success led to widespread investigations in several states. Within a few years atrazine in oil applied post-emergence became a recommended treatment for use in both grain sorghum and corn.

Several tours of the demonstration plots were held. Chemical company representatives and state weed workers went on several 2-day tours starting in Brookings or Sioux Falls and ending in the Black Hills. County personnel were invited to join the tour as it passed through their counties and adjacent counties. Some county weed supervisors went on the entire trip.

Frost and Derscheid held several 2- to 3-day training schools for county weed board members, county weed supervisors, county agents, state weed inspectors and anyone else that wanted to attend.

The Department of Agriculture passed regulations making it mandatory for commercial sprayers to take a test to obtain a license to apply pesticides. In order to renew their license, they were required to attend a 2-day shortcourse on pest control or take a test. The test for weed control was prepared by Derscheid. A series of 2-day shortcourses were conducted at a half dozen locations in the state. Frost and Derscheid devoted one day to the discussion of weed control, herbicides and sprayer equipment. The next day B. H. Kantack, W. L. Berndt and L. S. Wood discussed insect control, safe use of pesticides and plant diseases. Later the schedule was changed so that meetings were held in the northern half of the state one year and the southern half the next.

Frost placed emphasis on the control of annual grassy weeds in row crops and the control of wild buckwheat and wild oats in small grain.

Most annual grassy weeds were controlled by the use of herbicides applied pre-emergence or by the use of atrazine applied shortly after emergence. Pre-emergence applications in corn increased from 11.6 thousand acres in 18 counties in 1964 to 80.8 thousand acres in 31 counties during 1966. Early post-emergence treatments increased from 635 acres in four counties in 1964 to 20.7 thousand acres in 13 counties in 1966.

Pre-emergence applications in sorghum increased from 3,000 acres in six counties in 1965 to 4,600 acres in twelve counties in 1966. Early post-emergence treatment was doubled in seven counties--from 1550 to 3100 acres. In seven counties, the use of pre-emergence application of herbicides in soybeans increased from 3,300 acres in 1965 to 8750 acres in 1966.

Dicamba, for wild buckwheat control, was used on a few acres on trial basis in 1964, but was applied to 9,000 acres in 1966. Barban was used on 5,000 acres for wild oats control in 1964, but was used on almost 23,000 acres in 1966.

Robert Parker III became the fifth Extension weed specialist in June 1967. He was asked to make two 15-minute films on weed control. Standard Oil Co. was paying for the films and several meetings were held to develop the outlines. During the summer of 1968 Parker and photographer Dan Johnson, from the Audio-Visual Department, spent many days and traveled several hundred miles securing the pictures needed. "Crops and Robbers" was a film about weed control in small grain. It premiered at the North Central Weed Control Conference held in Sioux Falls during December 1969. The other film portrayed the procedure for calibrating sprayers.

In 1968 it was estimated that annual grassy weeds infested most of the 3.7 million acres of corn, 550,000 of sorghum and 377,000 acres of soybeans reducing crop yields as much as 25%.

Wild buckwheat was a serious weed in wheat, barley and oats, and was resistant to 2,4-D. It was found in 93% of 45 wheat fields checked in northeastern South Dakota, and buckwheat seed was found in 61% of 361 small grain samples checked in a drill box survey. Medium densities of 10 plants per square foot reduced wheat yields 3 1/2 bushels and barley yields 5 1/2 bushels per acre. Dockage losses and difficulty in harvesting infested fields were probably bigger problems than yield losses from the weed.

Most annual grassy weeds were controlled in corn, sorghum and soybeans by herbicides ap-

plied as pre-emergence or early post-emergence treatments. Surveys indicated that the number of acres treated has increased tremendously for both types of treatments.

Treatment	1964 (34)*	1966 (39)*	1968 (47)*
Pre-emergence in corn	15,425	107,300	300,950
Pre-emergence in sorghum	-----	6,295	39,831
Pre-emergence in soybeans	-----	13,550	44,215
Early post-emergence in corn	635	89,145	402,901
Early post-emergence in sorghum	-----	6,760	55,915
TOTAL	16,160	215,040	843,812

*Number of counties reporting

The addition of the acreage treated with 2,4-D in 1968 brought the total reported acreage treated with herbicides for weed control to 1,489,308 acres for corn and 162,966 acres for sorghum.

Herbicides specific for wild buckwheat control were applied to 46,400 acres, an increase of 19,200 acres over 1967 estimates. Another 2,563,472 acres of small grains were treated for broadleaved weed control with phenoxy herbicides, an increase of 1.1 million acres over 1967. Barban use increased by 6,290 acres in 1968. The use of herbicides to control weeds in trees increased from 3,700 acres in 1967 to 9,357 acres in 1968.

Parker continued to provide plans and herbicides to demonstrate the use of herbicides applied pre-emergence or early post-emergence to control annual grassy weeds in corn and for post-emergence application to control wild buckwheat and wild oats in small grain. However, the number of herbicides for these uses, especially pre-emergence in row crops, increased to the extent that county personnel did not have time or facilities to apply them.

In 1969 Parker made plans to secure herbicides and apply them in six to eight demonstrations for weed control in corn and sorghum and continue to let county personnel apply chemicals for wild oats and wild buckwheat control in small grain.

Leon J. Wrage began to apply the demonstrations shortly after he became Extension Agronomist-Weeds in 1969. Fourteen demonstrations on weed control in annual crops were conducted in 1978.

Herbicides were used in 1978 on 6.5 million acres of row crops and small grains. Pre-emergence row crop herbicides gave average performance, but pre-plant treatments were below average, especially when not incorporated properly. Because of favorable spring growing conditions, 2,4-D and dicamba caused more damage than usual.

Small grain herbicides performance was better than average. Two improved treatments recommended for Russian thistle and kochia gave 50% better weed control than the previous treatments.

Many of the Extension weed control activities were continued during the 1970s and into the 1980s. Changes in the herbicide area were reflected in program emphasis. The number of herbicides, formulations and two- and three-way combinations increased. Soil-applied herbicides were used in over 90% of the corn acreage in southeastern South Dakota by 1980. The number of industry sales and development personnel increased accordingly with the increase in products used (Wrage).

Large numbers of row crop treatments and specific timing for some treatments made it difficult for county agents to establish plots. Demonstration plots in corn and soybeans became a regular feature at the Experiment Farms near Beresford, Brookings and Redfield. In 1981, 90 different treatments were included in the corn and soybean plots. Additional sites for special weed problems such as velvetleaf or under irrigation were established cooperatively with county staff (Wrage).

Square rod plots to demonstrate 10 to 12 patch-control herbicides for noxious weeds continued to be made available in kits to county personnel. These often became the focal point of county noxious weed programs.

During the late 1970s, new applicator equipment became available. The use of Roundup in rope-wick applicators or recirculating sprayers became common for controlling volunteer corn and wild cane in soybeans. Spinning disc micro sprayers were introduced as band application equipment. Field models followed, making it possible to apply certain herbicides in 1 to 2 gallons of water per acre without forming extremely small droplets (Wrage).

New areas of chemical weed control appeared. Treatments such as low rates of Roundup + Banvel were used as a tillage alternative in fallow or after grain harvest on 100,000 acres in 1981. Chemical fallow aid using residual herbicides were used on a field scale on limited acreages. Herbicides for use in sunflowers became part of the Extension program as the

commercial sunflower acreage expanded from 1975 to 1979 (Wrage).

Individual consultations from county staff, dealers and applicators increased as herbicide programs became more complex. As many as 85 contacts were made in one day. Printed material continued to be in demand. Annual weed control recommendations were revised annually in five fact sheets. Annual distribution totaled 27,000 for the annual weed control recommendations (Wrage).

Proper Use of Pesticides

At all training schools, Extension weed specialists emphasized the need to use herbicides properly in order to avoid the hazards associated with their use. In 1964 Wayne L. Berndt was hired as the Extension Pesticide Safety Specialist. He appeared on the program for all schools held for commercial applicators to emphasize pesticide safety and discuss the regulations formulated and adapted by the federal Environmental Protection Agency.

By 1976 all applicators, commercial and private, would be required to have a license to buy certain "restricted pesticides," mostly insecticides. During 1975 four pesticide certification schools were designed to provide information needed to meet certification standards. They replaced the Agricultural Chemical Clinics. Dealers and applicators were required to pass a general examination and one or more of the eleven different pesticide examinations in order to obtain a license.

Subject matter at the schools was covered by B. H. Kantack, W. L. Berndt, L. S. Wood and L. J. Wrage. A total of 560 pesticide dealers and applicators attended the schools. Approximately 500 who attended completed at least some phase of the certification examinations. Over 960 passed the written examinations.

In order to maintain their licenses, dealers and applicators attended 1-day schools. Schools were held at each of six locations during January each year with a total attendance of 900 to 1,100 dealers, applicators and industry personnel. Personnel from the South Dakota Department of Agriculture and the regional office of the U.S. Environmental Protection Agency also participated in the schools.

County agents and vocational agriculture instructors were trained for the private applicator program. Training was provided by the Extension pesticide safety specialist and the newly appointed Extension pesticide safety coordinator.

One of the most severe droughts of all time hit South Dakota in 1976. Many people had questions about the results obtained from herbicides. Wrage and Derscheid were contacted by over 2,500 people between July 1, 1975, and June 30, 1976. Wrage wrote 765 letters during the year and received 269 telephone calls during 11 office days in June. In 1975-1976 Wrage identified more than 100 weed specimens and made suggestions on how to control them.

MULTI SPECIALIST ACTIVITIES

During the 1940s U.J. Norgaard, Extension Agronomist, Lenord Ladd, Extension Soil Conservationist and the Extension entomologist conducted several schools on the hazards of crop production--drought, soil erosion and grasshoppers.

Then, in 1958, soils, crops and livestock specialists launched a 3-year program on pasture renovation and improvement.

Farm Programs

For a decade beginning in 1963, the federal Wheat Stabilization program imposed acreage restrictions on wheat, and the Feed Grain program did the same for the combined acreage of corn, grain sorghum and barley. However, the acreage of the three feed grains could be interchanged. Since corn was a much more profitable crop than barley, it was obvious that barley and perhaps some sorghum acres would be planted to corn. Extension crops, soils and weed specialists emphasized the importance of efficiency in production.

Extension held 37 demonstrations on corn production--there were five on the control of quackgrass in corn, three on pre-emergence weed control, 18 on the use of fertilizer, two with fertilizer and weed control and nine on hybrid performance.

Extension agronomists stressed the importance of planting hybrids of the right maturity at the proper time and rate, the proper use of fertilizer and methods of controlling weeds in corn.

Corn maturity and rate and date of planting recommendations were different for each of seven areas in the state. For the area south-east of a line from Flandreau to Yankton they recommended 100- to 110-day (2700 to 3,000 growing degree days) a population of 14,000 to 18,000 plants per acre planted about May 10. Farther west, but southeast of the line from Brookings to Woonsocket to Wagner, they suggested 100- to 105-day maturity (2,800-3,000 GGD) with 14,000 to 18,000 plants seeded in mid-May. Recommendations for the Whetstone Valley, Hamlin, Kingsbury and Brookings coun-

ties were 90- to 95-day maturity (2500 GGD) and a 14,000-to 16,000-plant population planted in mid-May; for the Prairie Coteau and north central counties east of the Missouri recommendations were for 85- to 95-day maturity (2,400-2,700 GGD) and 8,000 (northwest counties of area) to 14,000 plants (eastern counties of area) planted around May 24; for south central counties recommendations were 8,000 to 12,000 plants, of 95- to 100-day maturity (2,800-3,000 GGD) planted around May 10; for Bennett, Todd, Mellette and Washabaugh counties 6,000 to 8,000 plants per acre of a 90- to 95-day maturity (2,800-2,900 GGD) were suggested; and 4,000 to 6,000 plants of 85- to 90-day maturity were suggested in dryland for the remainder of West River (FS 523).

The Extension Agronomist-Weeds emphasized the use of high rates of atrazine to control quackgrass, lower rates for foxtail and 2,4-D for broadleaved weed control in corn.

The Extension Agronomist-Soils strongly urged farmers to test their soil and use commercial fertilizer where needed to produce high yield and to restore and/or maintain high levels of nitrogen and phosphorus in the soil.

The Extension Entomologist encouraged farmers to use insecticides for corn rootworm and/or corn borer control when conditions warranted their use.

As a result of improved management, above average rainfall and a late fall, the 3.77 million acres (100,000 less than 1957-61 average) of corn planted in 1963 produced an average of 48 bushels per acre--5.5 bushels above the previous high and 16.2 above 1957-1961 average. The 150 million bushels were 34% above the 1962 production and 55% above the 1957-1961 average.

Billion Dollar Agriculture

During 1967, plant and animal science specialists set production and management goals. In the Extension circular, "Billion Dollar Agriculture in South Dakota," they estimated that South Dakota agriculture had the potential to produce a \$1.15 billion yearly income largely by improving farm management efficiency and by producing higher quality products for more specific markets.

In the foreword, Director J. T. Stone said, "There are many ways this goal might be achieved--better prices, expanded irrigation, increased processing, improved production efficiency...We have picked...one of these ways--improved farm and ranch management..."

Through better management and broader adoption of improved crops and livestock practices,

it was estimated that the state's management income could be increased \$162 million yearly for an average of an additional \$3,555 for each of the 45,000 farms.

Livestock, dairy and poultry specialists estimated a total increase in management efficiency income of \$74.34 million.

They estimated that the \$285.6 million income from beef could be increased by \$239 million by:

1. Increasing weaning weight of 1.1 million calves by 50 pounds.
2. Feeding another 1/4 million calves--half to 700 pounds and half to finished weight.
3. Increasing the calving rate of bred cows from 85 to 90%.

The average cash income of almost \$111 million dollars from swine could be increased by an estimated \$19.2 million by:

1. Increasing number of pigs marketed from 7.1 to 9.2 per litter for 450,000 sows.
2. Producing an additional 60,000 litters by double farrowing.
3. Improving efficiency of feeding and housing by \$2 for each of the 3 million hogs marketed.

Sheep income could be increased from \$32.6 million to \$36.1 million by:

1. Increasing live numbers by 10% or about \$123,000.
2. Increasing lamb crop sold from 105% to 140% of the number of ewes.

Dairy income could be increased \$17.8 million above the average of \$31.64 million by increasing milk production per cow from 6,400 pounds to 10,000 pounds.

Poultry income of \$30 million in 1965 could be increased an estimated \$9.9 million by:

1. Increasing egg production per hen from 218 to 246.
2. Producing an additional 450,000 layers for a total of 6.5 million.
3. Improving egg quality for higher market price of 4 cents per dozen.
4. Increasing turkey production 20 to 25% to about 1.5 million.

Crops, soils, weed, entomology and pathology specialists estimated a total management efficiency income from crops of \$88.27 million. They recommended:

1. Grow disease-resistant varieties of crops that best fit the climate and soil. Replace poor stands of grass on class 2, 3 and 4 soils with more profitable cultivated crops. Replace cultivated crops on classes 5, 6 and 7 soils with perennial grasses.
2. Use optimum rates of fertilizer and control weeds and insects.
3. Adopt practices that utilize the moisture received where it falls. Prevent water runoff and reduce evaporation.
4. Use optimum rates of fertilizer and control weeds, insects and diseases.
5. Use improved crops and soils management practices such as narrow rows, in some areas, for corn and sorghum.

They estimated that an additional investment of \$60.2 million--\$42.5 for fertilizer, \$15.2 for control of weeds, disease and crop insects and 2.5 for harvesting a more bountiful crop--would yield an additional \$148.47 gross income. A more efficient use of 14.6 million acres of cultivated land could increase income from cultivated crops by \$86.62 million. More efficient use of 1.4 million acres of wild hay could increase income by \$1.55 million.

The estimate did not include increased income that could be realized through use of irrigation nor the increased income through efficient management of 30 million acres of grazing land.

Potential yields were estimated for 13 areas of the state, but did not include about 100,000 acres around the Black Hills, much of which was irrigated.

The millions of dollars in efficiency income were estimated to be 25.88 for corn, 15.88 for oats, 11.51 for alfalfa, 9.55 for spring wheat, 9.10 for flax, 6.51 for barley, 3.36 for winter wheat, 2.11 for soybeans, 1.55 for wild hay, 1.11 for durum wheat, 0.94 for sorghum and 0.77 for winter rye.

Cash farm income for the state, in 1966 when the estimates were made, was \$881.6 million--\$682.7 million from livestock and \$198.9 million from cash sales of grain. Cash farm income raised to \$908.7 million in 1967, \$941.9 in 1968, \$976.2 million in 1969 and \$1.0 billion in 1970.

Though increased production efficiency accounted for part of the increase, market price accounted for a major portion of it. From 1966 to 1970, market price rose 5% while cash farm income raised about 6%. It appeared that 80 to 85% of the increased income was from higher market prices and the remainder from increased production efficiency.

Soil Atlas and Production Guides

F. C. Westin, head of soil survey, and Derscheid wrote a circular in 1968 entitled "Soil Atlas and Crop Production Guide for North Central South Dakota." It contained six sections discussing (1) the soils, topography and climate of the 16-county area; (2) environmental effects on crop production; (3) the present crop production in terms of acres, yield and total production; (4) the potential yield of each crop on each soil; (5) practices needed to obtain potential yield; and (6) the costs and returns under present conditions and under the conditions needed to give the potential yields. It indicated that over \$19 million more would be spent for production but that net profit for labor, management and land would be increased by \$26 million.

The authors made a dual presentation of the material in the circular at the SDCIA Annual Meeting in Aberdeen during March 1968 and at eight county meetings.

Interest in overall approach to crop production used in the Soil Atlas and Crop Production Guide was manifest by the 500 people who attended the meetings where the circular was discussed. People were given an opportunity to pick up a copy of the atlas but were asked not to take it if they didn't think it would be of value to them. The supply of 1500 copies was completely exhausted and 50 or 60 others indicated that they wanted copies if it were reprinted.

A similar circular was printed for the 10 northeastern counties and a similar series of meetings was held in 1969. One dollar was charged for each copy of the circular.

A third circular for the southeast counties was ready to print. However, when it was learned that northeastern farmers were unwilling to pay \$1 for a copy, the program was discontinued.

Shortcourses

By 1962, the demand for Agronomy specialists to attend county meetings was so great that they could not fulfill all requests. Specialists began to search for ways to multiply their efforts. One way, it seemed, would be to give county agents more in-depth

training on agronomic subjects so they could conduct some of their own meetings.

Langin and Adams developed a County Agent Soil Management Shortcourse. The 6-lesson shortcourse was presented to county agents and personnel from federal agencies in the south-east Extension district during the fall of 1962. During November and December, of 1963, 20 county agents and others from the northeast district attended the workshop. The six lessons were as follows:

Soil fundamentals-morphology, genesis and physical characteristics . . . F.C. Westin

Chemical characteristics of soil minerals and organic matter L. O. Fine

Essential plant nutrients and their attachment to soil particles . . . F. E. Shubeck
E. J. Langin

Soil fertility and management...P.L. Carson

Conservation needs, development and application E. P. Adams

Nutrient deficienciesR. C. Ward

Written material and slides were prepared for county agents to use when conducting their own soil and fertilizer meetings. These expectations were not fulfilled and it became apparent that another system would have to be developed.

In 1968 Derscheid organized a series of corn-soybean clinics to present in southeastern counties. Plans were made to present the corn-soybean shortcourse in four sessions spaced one week apart during the last 2 weeks in January and the first 2 weeks in February of 1969.

Plans were submitted to county agents and they were asked to determine the number of farmers that would be interested in attending the events. Approximately 500 farmers in 13 counties indicated they would attend the four meetings in the corn-soybean clinics and there were several requests for corn-sorghum clinics in the south central counties for 1970.

The corn-soybean clinics were held. In the first lesson Sanderson discussed yield potentials and growth characteristics of corn and soybeans; F. E. Shubeck, a crop production researcher, talked about plant populations, narrow rows, minimum tillage, plant orientation and related topics; and G. R. Durland, Extension agricultural engineer, covered the machinery for planting corn and soybeans.

Adams and Williamson discussed soil fer-

tility and soil and water conservation in corn and soybeans during the second session. The topics of weed control, insect control and diseases in corn and soybeans were covered by Wrage, Kantack and Wood during the third lesson.

Methods of harvesting and drying were outlined by W. Peterson, Extension agricultural engineer, during the fourth lesson, and A. Sogn, an Extension economist, concluded the series with a discussion of the future markets and how corn and soybean producers could utilize these markets to their own advantage.

During 1970 a similar clinic was held for corn and sorghum in south central counties. A year or two later the two shortcourses were condensed into a 4-hour session. Sanderson or his successor and Adams covered the first two lessons in one 2-hour session, while Wrage, Kantack and Sogn discussed weeds, insects and marketing in a similar meeting. Sometimes the two groups were in adjacent counties during the forenoon and switched locations during the noon hour, making it possible to present the shortcourse in two counties each day.

West River county agents in 1970 asked for an in-depth shortcourse on forage crops. At a district meeting they suggested the topics to be discussed at three meetings held at weekly intervals. The shortcourse was presented in 10 counties in 1971. During the first week Derscheid discussed alfalfa and perennial grass varieties and their establishment and management for hay production. Cline discussed the use of annual crops for forage production and used a narrated slide set prepared by entomologists to discuss alfalfa weevil and its control.

During the second week Williamson discussed the use of fertilizer on perennial forage crops; R. Durland, Extension agricultural engineer, discussed forage harvesting and storage; and W. A. Aanderud, Extension farm management specialist, discussed the economics of forage and grazing land for livestock production. During the third week, two West River Extension livestock specialists, J. Minyard and M. Crandall, discussed the utilization of forage by livestock at each of the 10 locations.

After the first year it was decided that one 4-hour meeting would be better than three 2-hour sessions. Derscheid condensed the material given by Cline, Williamson and himself into a 1-hour presentation. Aanderud and Durland continued their presentations and J. O'Connell discussed forage crop utilization by beef cattle. It was presented in 10 north central counties in 1972 and about a half dozen counties each of the next 4 or 5 years.

A cow-calf production shortcourse was presented annually in six to eight counties each year during the mid-1970s. Derscheid discussed pasture and forage alternatives for various periods of the grazing-season, O'Connell the wintering of the beef cow, and Durland forage harvesting and storing. During the fourth hour, Minyard discussed crossbreeding of beef cattle and J. Bailey, Extension veterinarian talked about beef cattle diseases.

The 4-hour spring grain clinic initiated in the mid-1970s, included six topics: (1) how crops grow, varieties and cultural practices by Sanderson and successors Colburn and Reid; (2) fertilization by Adams; (3) weed control by Wrage; (4) crop insect control by Kantack; (5) crop diseases by Wood; and (6) either crop drying and storage by Peterson or market outlook by Sogn. In later years topics concerning insects, diseases and crop drying and storage were omitted.

The winter grain clinic included three 1-hour sessions: (1) varieties, cultural practices and weed control by Cline and successors Johnson and Stymiest; (2) fertilization and conservation by Williamson; and (3) insects and diseases by Kantack and Wood.

Crop Production

Crop production programs changed several times in two decades. During the 1950s farmers were encouraged to plant forage crops to help maintain soil fertility, reduce soil erosion and meet the needs of an expanding livestock industry. Cost-share payments were made for the planting of soil conserving crops and the Soil Bank Program came into being. Though farmers were remunerated for these programs, the production of food and feed crops increased. By 1961, the crop surplus reached an all-time high of 1.411 billion bushels for wheat and relatively high levels for feed grains. As a result, the federal Wheat Stabilization and Feed Grain programs came into being. The term "maximum production" became dirty words and was replaced by the term "efficient production".

Because of the farm programs, the supply of most crops diminished. In 1973-74, the carry out of wheat was 17% of one year's needs. It was 11% for all feed grains and less than 10% for corn. Market prices were considerably higher than for the previous year. The small carry out in 1973-74 was a small carry in for 1974-75. The total supplies of both wheat and corn were down and market prices reached high points. The farm programs were discontinued and acreage restrictions were removed.

Crop production programs changed. They were aimed at achieving the goals of the

USDA--the production of more food. Crop producers planted crops on areas that had not been cropped in recent years. In South Dakota this included 1 1/4 million acres of native range that had been plowed. These areas were, in general, less productive than those used in the recent past. Some were not well suited to the production of food crops. However, 10 bushels of wheat per acre could be produced on the same land where three or four steers could be raised. Ten bushels of 2-dollar wheat was equal to 45-cent steers. Wheat prices went to \$4.00 a bushel and steer prices dropped to 25¢ per pound. Farmers in South Dakota were urged to obtain "maximum production without destruction" of natural resources.

The costs of fuel, ag chemicals and equipment had doubled and could cause some producers to use fewer tillage operations, less fertilizer and/or reduced amounts of herbicides and insecticides. With crops being planted on less productive acres and probable that less fertilizer and pesticides would be used, it seemed likely that average yield per acre might be lower. Therefore, a second crop production goal was to maintain average yields--the mean for an average 5-year period, 1968-72.

The 5-year goals set in 1975 were: (1) maintain or increase the 1968-1972 average yields per acre for all crops; and (2) increase wheat production by 25%, oil crops by 15%, and feed grains by 10% through the use of high quality seed of disease-resistant, high yielding varieties of adapted crops, efficient use of fertilizer and tillage operations, weed control, disease control and soil and water conservation practices.

In 1975, cold, wet spring weather delayed field work. Crops made fair progress until June, but hot, dry weather in July depleted soil moisture, causing serious crop damage. Small grains were forced to maturity while corn and sorghum made poor progress. In spite of the weather, production goals were reached for barley, wheat and soybeans, and yield goals were achieved or exceeded with winter grains and soybeans.

In 1976 South Dakota acreages increased 48% for durum, 28% for HRW wheat, 25% for HRS wheat, 5% for corn and 5% for flax. Acreage was unchanged for oats and soybeans and decreased for barley and sorghum.

Small grains were damaged by four killing frosts during the first 6 days of May in 1976 and less precipitation was recorded in most of the eastern two-thirds of the state than in 1934. However, the low yields of 1976 were two to three times as high as those obtained 40 years earlier. Farmers did a better job of

producing crops in 1976 than in 1934 because they had better varieties and technology for pest control and soil management which had been developed by research and disseminated by the Cooperative Extension Service.

The drought left little or no sub-soil moisture for the 1977 crop. Since seasonal rainfall was generally low in July and August, long-season crops depended on sub-soil moisture for that period. It seemed unwise to plant long-season crops in many areas of South Dakota in 1977.

Farmers were encouraged to reduce acreage of winter-sown crops and long-season crops, especially corn, and increase acreage of spring-seeded grain crops, using early maturing varieties. Because of market outlook, they were encouraged to reduce acreage of spring wheat, especially durum, and increase acreage of oil crops.

The 1977 South Dakota acreages were reduced 200,000 acres (7%) for corn, 200,000 (9%) for HRS wheat, 30,000 (5%) for HRW wheat, and 65,000 (30%) for durum. There were increases of 360,000 acres (11%) for oats, 10,000 (17%) for barley, 95,000 (24%) for sorghum, 30,000 (11%) for soybeans, 90,000 (13%) for flax and 40,000 (50%) for sunflowers.

A change in the U.S. farm program in 1978 made it necessary to change emphasis in the Extension crop production program once again.

The farm program for wheat and feed grains (corn, barley and grain sorghum) was a voluntary program in which participants set aside 20 acres for every 100 acres of wheat planted and 10 acres for every 100 acres of feed grains planted. "Loan prices" were set for corn, barley, sorghum, rye and oats. "Target prices" were set for wheat, corn, barley and sorghum. It appeared that many wheat and grain producers would be eligible for "deficiency payments" if they participated in the farm program.

There was considerable winter kill of winter wheat and a large majority of the crop north of U.S. Highway 14 had to be replaced. The spring of 1978 was wetter than usual and seeding of most spring grains was delayed 2 to 3 weeks.

Farmers were encouraged to participate in the farm program and a fact sheet outlined different ways to handle the "set-aside" acres. Winter wheat farmers were encouraged to replace some winter wheat with grass-legume mixtures or protected fallow. As wet weather delayed seeding, spring wheat farmers in northern counties were encouraged to plant less wheat and more oats, barley and sunflowers.

Farther south, farmers were encouraged to replace oats with corn and soybeans. Overall they were encouraged to reduce acreage of HRW and HRS wheat and flax, to hold corn acreage below the 1976 level and to increase acreage of soybeans, sunflowers and perhaps durum wheat.

Of the 54,735 farms in South Dakota, 35,682 participated in the farm program. The acres planted in 1978 when compared to 1977, were lower by 50,000 for HRS wheat, 80,000 for HRW wheat, 65,000 for flax and 80,000 for barley. Increases were 55,000 for soybeans, 45,000 for durum, 65,000 for winter rye, and 15,000 to 25,000 for sunflowers. Corn acreage was 250,000 above 1977 but only 50,000 above the 1976 level. Oats acreage was 350,000 below the 1977 acreage and 10,000 above that for 1976.

Market Outlook For Crop Selection

Starting in 1972, South Dakota farmers were encouraged to use market outlook and cost of production estimates for adapted crops to help determine which crops to plant.

The annual estimates of production published by the USDA served as a starting point for determining which crops would be most profitable. Data on production, utilization and carry over were presented for all major crops to farmers at small grain clinics, row crop clinics, county crop outlook meetings, regional crop outlook seminars, radio programs and a Public TV program. The anticipated market price (market outlook) was given for each crop.

In addition, a series of six publications was published annually that gave estimated costs of production for eight major crops in six 6- to 10-county areas. Farmers were encouraged to calculate their own costs of production if they did not agree with the estimates in the publications. They then were encouraged to compare the cost of producing a bushel of grain with the anticipated market price for each of the crops adapted to their farms and to plant the crops that appeared to have the best chances of showing a profit.

While market prices for most crops were declining, costs of production were rising. The cost of pesticides, fertilizer, labor, machinery, land, interest and taxes all increased. The cost of a pound of 2,4-D amine, for example, raised from \$1.30 in 1974 to \$2.10 in 1978. The average price for nitrogen was 7 cents per pound in 1973, and 17 cents in 1978, while phosphate prices rose from 5 to 16 cents per pound between 1973 and 1978. Machinery prices almost tripled during the 5-or 6-year period. As a result, the estimated

corn production costs rose from \$1.57 per bushel in southeastern South Dakota during 1974 to \$1.97 in 1978. HRS wheat production costs in north central counties ranged from \$2.10 to \$3.45 per bushel for the same years.

The economy reached a point where there was no incentive to produce maximum yields. It became necessary to consider practices that would produce a bushel for less than the anticipated market price. If the outlook were \$2.00 per bushel for corn and it cost \$2.00 per bushel to raise 100 bu/A, there would be no profit. However, if 75 bu/A could be raised under minimum tillage for \$1.75 per bushel, there could be a profit.

In a result demonstration Extension soils specialist Ed Williamson and Extension Ag Engineer G. R. Durland compared three tillage methods for corn production and calculated costs of production. Fuel and machinery costs were \$8.73 per acre for conventional, \$7.31 for reduced tillage and \$5.40 for no-till. Gasoline requirements were 5.6, 4.55 and 2.88 gallons per acre. Cost per bushel was approximately the same for 100 bushel/A on conventional, 83 for reduced tillage and 62 bushels for no-till, indicating that 62 bushels on no-till would be just as profitable as 100 bushels on conventional tillage.

Research results from a corn-soybean rotation on the Southeast Experiment Farm showed that corn and soybean yields were very similar on seedbeds that had been chiseled, disked or plowed. The same was true for soybeans following oats.

Consequently, farmers were encouraged to study their crop production practices with the view of reducing tillage costs.

Specialized Assistance

Every so often a drought, late frost, hail or other factor made it necessary for specialists to give specialized assistance.

Hay and Pasture

Because of the severe drought in 1976, yields of all crops were poor. Most livestock producers did not have enough grass or forage to maintain their herds. Derscheid was the Extension coordinator for the program to locate hay or pasture. He sent an SOS to all the states in the upper Great Plains. In cooperation with the South Dakota Department of Agriculture, lists of people with hay for sale or pasture for rent to farmers in the drought-stricken areas were compiled. The lists were updated and circulated for 19 weeks to county Extension offices and county ASCS offices so cattlemen could find hay or pasture in other states or Canadian provinces.

Over 10,000 names were on the hay and rough-age list and about 1,000 people had pasture and/or overwintering facilities for rent. More than 4,200 farmers checked these lists in Extension offices. Many others checked them in ASCS offices. Since others learned of listings from neighbors who reviewed the list, it was estimated that more than 8,000 cattlemen received information from the lists.

By the end of 1976 county agents reported that more than 560,000 tons of hay had been imported into 35 counties and that 120,000 to 125,000 head of cattle had been moved to pasture or overwintering facilities. The ASCS reported that it paid trucking costs for 707,796 tons of hay and for moving 167,148 head of cattle out of state.

Nitrate Tests

Because of the drought of 1976, many livestock producers decided to harvest small grain for forage. Since drought-stricken small grain forages were frequently high in nitrate, which are toxic to ruminants, Derscheid asked several county agents to collect a total of 50 samples of small grain in various parts of the state. The samples were tested for potassium nitrate content by the Biochemistry Department. About 40% of the samples were safe to feed, but 60% of the samples contained enough nitrates so that they should be mixed with other forage.

Farmers were encouraged to test their forage shortly before feeding it. As a result 1,229 samples were analyzed for nitrates and 163 for prussic acid between July 1, 1976 and June 30, 1977. This was six times the normal number of about 200 nitrate samples per year.

Miscellaneous Assistance

Special assistance was given with problems that were either actually caused by, or suspected of being caused by unusual climate, herbicides, insects, disease or nutrient deficiencies. In 1976-77 215 plant specimens were submitted for identification, 1171 for diagnosis of disease, 39 for plant nutrition, 45 for possible pesticide damage and 35 for other reasons.

Extension agronomists spent 125 man-days examining the 1405 plant specimens and consulting with 2273 individuals about these special problems during 1976-77.

For the year 1977-1978, a severe blizzard struck on November 7. It covered the eastern half of the state. Snow that remained all winter drifted into tree plantings and unharvested corn, soybeans and sunflowers. Many acres of long-season crops were not harvested

until spring. The heavy snow blanket began to melt in March and most of the ice was out of the rivers by the third week in March. Soils in northern counties were relatively moist and cool until late April.

A large majority of the winter wheat north of U.S. Highway 14 winter killed as did 35 to 50% of the crop between U.S. 14 and Interstate 90.

Above average spring rains delayed planting of spring grains by 2 to 3 weeks. These crops were hit with a few days of hot, dry weather resulting in poor yields and low test weight. In addition, there was a severe outbreak of Hessian fly on spring wheat in north central South Dakota.

This special set of environmental conditions caused many farmers to ask for special assistance with problems suspected of being caused by unusual environment, herbicides, insects, disease or nutrient deficiency. A total of 1775 plant specimens were examined and 367 consultations were given by specialists in Extension Agronomy.

Total Contacts

Extension agronomists released about 10 news stories per month, 74 radio programs over each of 15 radio stations each year, several 30-minute TV shows over the 5-station public television network, and about 75 fact sheets were available on as many topics. They conducted about 50 crop variety demonstrations, a dozen demonstrations on each soil fertility and weed control and as few as 2 in some years or as many as 20 in other years on pasture management and improvement. For example, the TVA, sponsored a fertilizer-use program, under the supervision of Extension personnel. It included 256 farmer and rancher cooperators in different parts of the state in 25 years.

Plant scientists annually participated in over 200 meetings to discuss crop production topics with about 7,000 farmers and ranchers. They conducted day-long producer "in-depth" training sessions on soils and soil fertility, corn and soybean production, spring grain and flax production, winter wheat production, pasture improvement and management, and forage crop production and utilization. They annually participated in nine district weed meetings, eight district crop improvement meetings, three to five agricultural chemical clinics and a similar number of district fertilizer association meetings.

In 1976, E. M. White calculated the number of farmer contacts made by Extension specialists in individual consultations or at group meetings for 4 years during the mid-1970s.

Contacts were calculated by multiplying the number of people who contacted an Extension agronomist or attended a meeting. If several specialists gave talks at a meeting, each talk was considered as a separate contact with those attending the meeting.

Contacts in the Plant Science subject areas by the Cooperative Extension Service.

	1970-71	1971-72	1972-73	1973-74
Crop production, weed control and plant disease control	53913	51429	39146	45566
Pasture and range	5453	5042	4379	5091
Hay and haylage	1942	2936	2583	3287
Silage	515	1074	469	289
Fertilizers	7766	9605	7063	9113
Soil	7962	5896	8148	5896
Water	6411	9106	7488	9205
Weeds and brush	<u>17235</u>	<u>16159</u>	<u>16860</u>	<u>15689</u>
	101,198	101,247	86,136	94,136

With fewer agronomy specialists in 1980-81, the number of contacts was reduced somewhat, but 129,000 Plant Science fact sheets were distributed (Wrage).

Commodity	Days	Contacts
Animal Science	6,058	149,478
Horticulture	1,108	14,239
Plant Science		
Noxious weeds	343	4,253
Crops-General	4638	61,721
Wheat	365	4,470
Small grain, other	150	1,912
Corn	509	3,965
Grain sorghum	26	138
Soybeans	182	1,571
Flax	30	364
Oilseed, other	203	2,477
Potatoes	34	39
Forage crops	312	4,381
Pasture & Range	622	5,775
Total Plant Science	7,428	91,066

YOUTH ACTIVITIES

Several youth activities were sponsored each year.

Grass and Range Plants

Each year the Extension agronomist for West River (Cline, Hoeft, Johnson and Stymiest, in order) conducted grass and range plant schools or workshops for 4-H members, 4-H leaders and others. Grass and range plant identification contests were held each year at the Western Junior Livestock Show in Rapid City in early October.

In 1961 Junior 4-H members had to identify 14 grass and range plant specimens and give information as to origin, type of plant and season of growth for each. Senior 4-H members, 4-H leaders and other adults had to identify 20 specimens (11 grasses and 9 forbs) and give information on type, origin, life span, season of growth and relative forage value. In addition, each contestant judged two classes of tame and wild hay. A total of 38 contestants from eight counties participated in 1961. The program was modified to some extent over the years.

Grass and range plants were collected, pressed, mounted in books and exhibited by 4-H members at 4-H Achievement Days, State Fair and at the Western Junior Livestock Show. Written material about each specimen was included in the books, which were judged for accuracy, completeness and neatness.

To assist with this program R. A. Cline, Extension Agronomist; Kenneth Nelson, State 4-H Club Agent; and J. K. Lewis prepared a Range and Pasture 4-H Guide for youth and leaders.

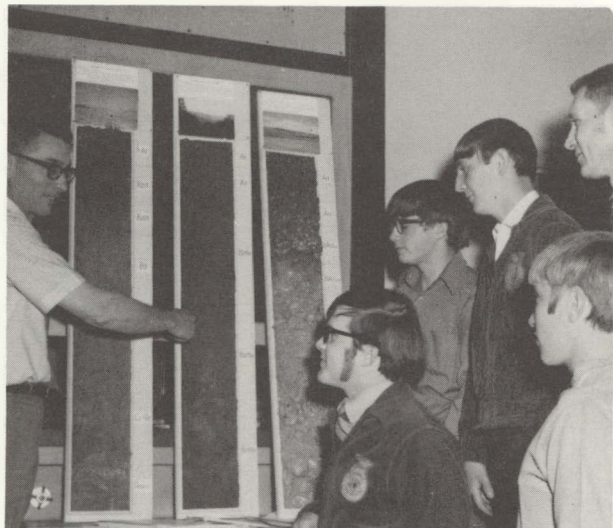
Area Land and Range Judging Contests

Williamson continued the Know Your Land program. Land judging schools and contests were held at three or four locations each year for 4-H and FFA. Vocational agricultural instructors took an active part and the number of FFA members far exceeded the number from 4-H.

Contests were held at Watertown, Sioux Falls and Mitchell in 1961. Winners from the contests became members of teams that competed in the national contest in Oklahoma. Four 4-person FFA teams and one 4-H team went in 1961. Each year Williamson held a training session for national contestants, generally at SDSU during the state FFA judging contest, shortly before the national contest. He accompanied the teams to Oklahoma.

Contests were held in areas where sponsors provided funds to send a team to the national contest. During the early 1960s, bankers at Aberdeen and Mitchell withdrew their support as did the sponsors at Watertown. Wessington

Springs replaced Mitchell and in 1968 two area Know Your Land Program events (land judging for youth) were held in cooperation with local conservation districts, county agents and vocational agriculture instructors. Contests were held for the southern area at Sioux Falls and for the south central area at Wessington Springs.



E.J. Williamson conducting training session for land judges prior to going to National Contest.

Starting in 1975 the State Department of Agriculture provided funds for the trip to the national contest. About 800 youth, mostly FFA members, participated in 1975. The four top individuals from each of three contests (Sioux Falls, Wessington Springs and Wall) received more training at SDSU in April and went to Oklahoma City in May.

James R. Johnson rejuvenated the grassland evaluation school and contest initiated by Cline in 1954. Starting in 1976, they were held in conjunction with the land judging contests. Contests after that date were held at four locations: Sioux Falls, Wessington Springs, Wall and Roslyn. The Department of Agriculture provided \$500 for each of eight teams to go to the national contests in Oklahoma. One team of land judges and one team of range judges was selected at each of three locations. Range evaluation contests were not held at Sioux Falls, so two teams of land judges were selected at that location.

Crop Judging and Weed Identification

During the 1960s, Sanderson conducted two or three area crop judging and weed identification contests for FFA and 4-H. In 1961, 65 contestants at Watertown and 110 at Huron judged five classes of seed (oats, barley, wheat, sorghum and shelled corn) and identified crop seeds, weed seeds, weed plants and plant diseases.

Similar contests have been held for 4-H at the State Fair every year. Sanderson or his successors were in charge of the contest.

In other workshops 4-H members, club leaders and county agents were taught the procedures, techniques and principles used in judging crops. They were also given pointers for identifying grasses, crop seeds and crop diseases. Each workshop concluded with some practice judging and identification.

The purpose of these workshops was to train and develop a crop project leader in each county. The county project leader would in turn assist interested 4-H crop members in crop judging and identification of weeds, weed seeds, crops and crop diseases. Participants were informed as to teaching aids available from the Extension agronomists (Sanderson).

Extension agronomists devoted about 3 weeks in 1978 to youth activities in crops. Reid and Wrage, with the assistance of vocational agricultural instructors, conducted a crop-judging weed-identification contest for 80 FFA students from eight schools during the State Crop Show at Yankton. Colburn and Wrage continued to conduct the state FFA contest at SDSC for 165 students from 55 schools. Reid, with the assistance of county agents, continued to conduct the state 4-H contest at the State Fair. A total of 87 contestants (11 teams each from junior and senior divisions) participated in 1978.

COOPERATION WITH FEDERAL AGENCIES

Derscheid was the Extension liaison with the federal agencies. Starting in 1960, he and the SCS Agronomist served as co-chairmen of the inter-agency committee to write the agronomic sections of a technical guide to be used by all state and federal agencies.

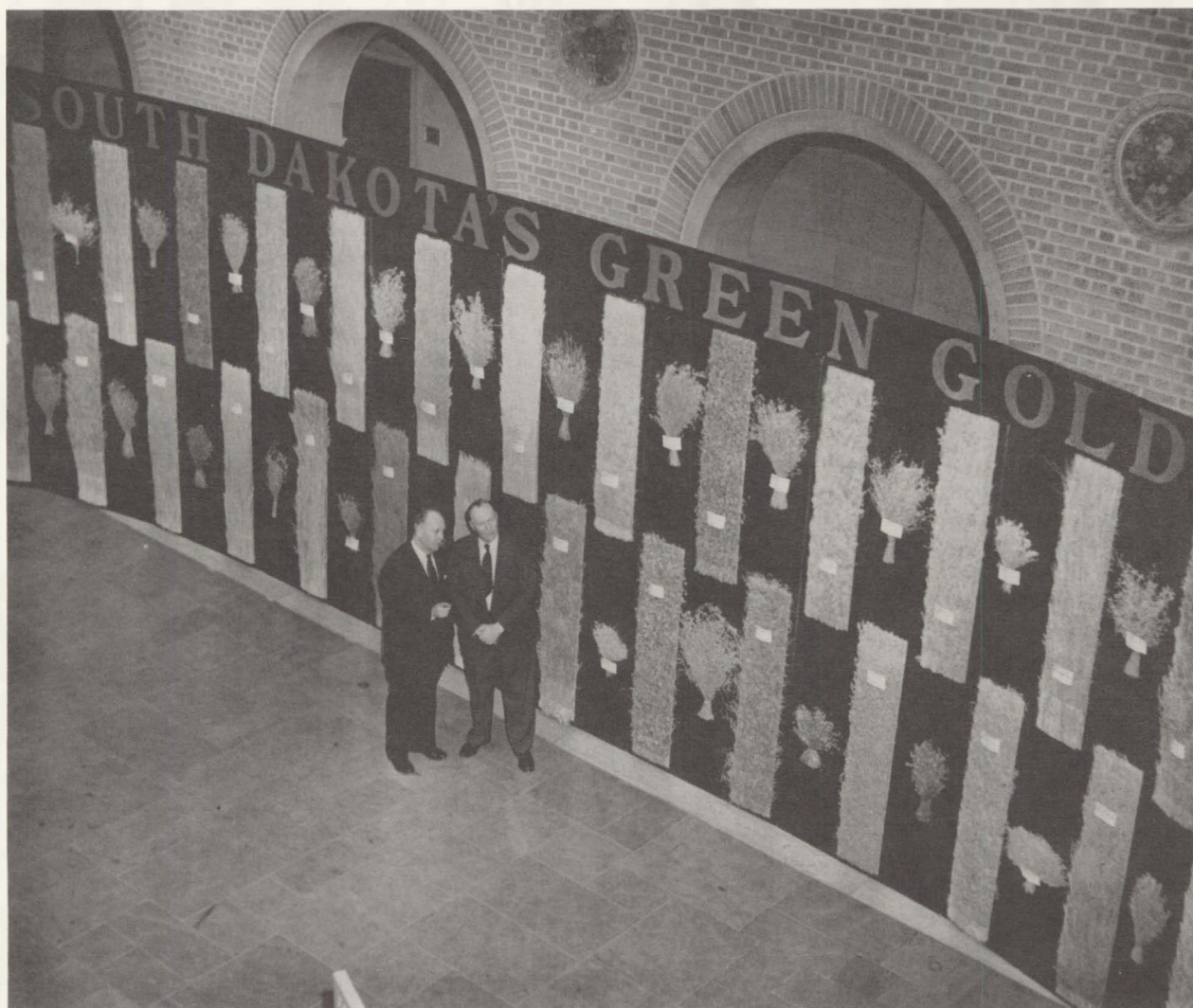
The state was divided into six areas based on soils, climate and crop adaptability. A separate guide for each area was divided into five sections: I. General information; II. Soil and site information; III. Land use and treatment alternatives; IV. Standards and specifications; V. Conservation cost-return information. Derscheid and/or Williamson met 19 times with SCS and ASCS personnel in 1961 to prepare the material for crop and pasture yields in section II, alternative cropping sequences and alternative pasture and hayland groupings in section III and cropland practices and pasture land practices in section IV.

After the guides were completed Derscheid and several SCS staff members conducted a series of area meetings to discuss the guide with county personnel from Extension, SCS,

ASCS and other state and federal agencies. Almost every year some phase of the guide was updated. Derscheid also wrote fact sheets to extend the information in the guide to all farmers.

Also starting in 1961, Derscheid and sometimes

Williamson or Fine, the Head of Agronomy, met annually with the ASCS and SCS to develop the Agricultural Conservation Program (ACP) docket which included conservation practices for which the ASCS made cost-sharing payments.



S.D. Senator Karl Mundt visited the Extension Agronomy Exhibit at the "South Dakota's Green Gold."

CHAPTER XXXVIII RESIDENT INSTRUCTION IN AGRONOMY

A primary purpose of the Morrill Act in 1862 was to create land grant colleges to offer resident instruction in agriculture and mechanic arts. Resident instruction was undoubtedly foremost in the minds of the legislators that authorized the establishment of the Agricultural College on February 21, 1881. Three years later the Board of Regents established the Preparatory school for the purpose of training students for resident instruction at the college level.

During the first century the college had many UPS and many DOWNS. After enrollment was completed in 1981, it was observed that enrollment had undergone a COMPLETE REVERSAL--it had reversed from 0071 in 1884 to 7100+ in the 98th year.

The information in this chapter was taken from College catalogs and commencement programs. Catalogs were written during the spring of each year from 1885 to 1976, then biennial publications were issued in 1976-78, 1978-80 and 1980-82. The writer reviewed all 94 issues and B. L. Brage perused several copies as well as the commencement programs.

Since catalogs were printed in the spring they included the curricula and courses for the next academic year, but not always for the current year. Early editions listed the faculty for the next year but later issues included those for the current year.

Alumni were included in all catalogs until the 1921-22 issue, and students for the current year were included until 1940-41.

QUOTES FROM EARLY CATALOGS B. L. Brage

"The College occupies a pleasant and healthful location, within 3/4 of a mile of the business center of the City of Brookings, situated in the Great Sioux Valley within a few miles of the Sioux River. The climate is healthful at all seasons, soils of the finest quality, and the people hospitable, cultivated and high moral tone."

"While this is primarily a technical school, the Act of Congress requires that the leading objects shall be to teach such branches of learning as are related to agricultural and mechanical arts yet the same law explicitly provides that scientific and classical studies shall not be excluded."

"To accomplish the objects of this institution, it is evident that the student must not, in acquiring a scientific education, lose either the ability or disposition to labor on the farm. If the farmers are to be educated, they must be

educated on the farm itself. It was due to this large class of our population that the facilities for improvement, second to none other in the northwest be afforded them. The college will afford its students the benefits of daily manual labor sufficient for experimental purposes and to foster a taste for agricultural pursuits."

Some rules of conduct included in the catalog for 1886 were:

"The following are strictly forbidden: (1) the use of intoxicating liquors, (2) the frequenting of saloons, (3) the use of tobacco and any of its forms about the buildings or the grounds, (4) the use of profane language, all indecency of speech or behavior and all immorality of any kind, (5) card playing in or about the college buildings."

Dormitory regulations included some don'ts: "(1) Not throw slops or other refuses out of the windows, (2) not keep firearms about the dormitory buildings, (3) not visit the City of Brookings between the hours of 7 in the evening and 7 in the morning except by special permission of the professors in charge. Note the rule does not apply to Juniors and Seniors."

An interesting quote about the first students was stated in the catalog. "These young people are here. Time is rapidly passing with them. We need their strong arms and cultured brains out in the open field. They cannot afford to wait the movements of crafty congressional partisans, who block the way to statehood and rob us of our rightful school resources, nor can we afford to have them. State or no state, vital questions involving the peace and order, and property, the very life of mighty people are counting upon us for solutions."

AGRONOMIC TEACHERS

The Agriculturists and Agronomists included in catalogs for the first 60 years are listed below. The list does not include botanists listed on pages 7 and 9 of this report. Nor does it include non-teaching personnel located at the various substations or USDA employees in the Experiment Station.

The plant pathologists listed on pages 34 and 35 and the entomologists listed on page 43 were involved in teaching--some full-time. Many of the agronomists named on pages 18, 29 and 45 were teachers. J. S. Webster, for example, was a full-time teacher, while G. E. Nachtigal, D. E. Kratochvil and D. O. Beatty were half-time teachers most of their careers, and W. E. Arnold for several years. L. O. Fine and B. L. Brage were originally employed primarily as teachers.

Catalog date

Faculty Members

1886-92	Foster						
1893-1902	Chilcott						
1902-3	"	Holm					
1903-4	"	Cole					
1904-5	"	"					
1905-6	Cole						
1906-7	"						
1907-8	"						
1908-9	Willis	Bopp		Besley			
1909-10	"	"	Potter	"			
1910-11	"	"	Burlison	Loomis	Woodward		
1911-12	Hume	Hutton	Champlin	"	"		
1912-13	"	"	"	"	Oakland		
1913-14	"	"	"	"	"		
1914-15	"	"	"	"	Sloan	Rilling,	
1915-16	"	"	"	"	Fowlds	"	
1916-17	"	"	"	"	"	"	
1917-18	"	"	"	"	"	"	
1918-19	"	"	"	"	"	Winright	
1919-20	"	"	"	"	"	Bushey	Hoon
1920-21	"	"	Evans	Bushey	"	"	"
1921-22	"	"	"	"	"	"	"
1922-23	"	"	"	"	"	"	"
1923-24	"	"	Hardies	"	"	Larson	Franzke
1924-25	"	"	"	"	"	"	"
1925-26	"	"	"	"	"	"	"
1926-27	"	"	"	"	"	"	"
1927-28	"	"	"	Puhr	"	"	"
1928-29	"	"	Klages	"	"	"	"
1929-30	"	"	"	"	"	"	"
1930-31	"	"	"	"	"	"	"
1931-32	"	"	"	"	"	"	"
1932-33	"	"	"	"	"	"	"
1933-34	"	"	"	"	"	"	"
1934-35	"	"	"	"	"	"	"
1935-36	"	"	"	"	"	"	"
1936-37	"	"	Swenson	"	"	"	"
1937-38	"	"	"	"	"	"	"
1938-39	"	"	"	"	"	"	"
1939-40	"	Puhr	"	"	Erickson	"	"
1940-41	"	"	Grafius	Arms	"	"	"
1941-42	"	"	"	"	"	"	"
1942-43	"	"	"	"	"	Hehn	"
1943-44	Worzella	"	"	"	"	"	"
1944-45	"	"	"	"	"	"	"
1945-46	"	"	"	"	"	Manke	"
1946-47	"	"	"	"	"	"	"
1947-48	"	"	"	Williamson	"	Shank	"

On the other hand, Lyle A. Derscheid taught only one graduate course a year during 7 of his 33 years of service. J. D. Colburn taught an undergraduate course for a few of his 21 years and D. G. Kenefick did relatively little teaching. USDA employees and managers of Mobile Farms, Seed Certification Service or Foundation Seed Stock Division and several soil survey irrigation and performance testing personnel seldom taught regular classes. This includes Edgar Joy, G. D. Johnson, A. O. Syverud, G. Avery,

R. A. Cline, L. M. Stahler, R. Greenwalt, G. W. Erion, A. J. Klingelhoets, G. Lee, R. E. Campbell, F. Wiersma, H. M. Vance, Q. S. Kingsley, L. Wilding, C. Swanson, M. E. Sanders, P. B. Price, H. A. Geise, C. D. Dybing, Z. F. Lund, J. J. Bonnemann, T. C. Olson, J. Dosland, C. H. Chen, J. B. Weber, C. L. Lay and R. J. Pollmann.

Geneology of Positions

The names were arranged in the list to show

the geneology of several positions. The program leaders for agronomic topics were agriculturists Foster and Chilcott until 1905. Then the title of Agriculturist was discontinued and a department with the word "Agronomy" in its title did not exist for 3 years. Assistant Agronomist J. S. Cole was in the Agriculture Department and few agronomic courses were listed during 1905-6 to 1907-8. Starting in 1908-9 Chief in Agronomy Willis and the successive department heads--Hume, Worzella, Fine, Moore, Krueger and Horton--were the program leader.

The position of soils leader and assistant agronomy leader was in the hands of J.V. Bopp, J.G. Hutton and L. F. Puhr. Another position in soils was held successively by H. Loomis, A. L. Bushey, L. F. Puhr and R. Arms and was then vacant for several years. One position in crops traces through H. B. Potter, H. L. Burlison, M. Champlin, A. T. Evans, E. W. Hardies, K. H. W. Klages, S. P. Swenson and J. E. Grafius; another traces through C. M. Woodward, I. S. Oakland, S. L. Sloan, M. Fowlds and E. L. Erickson; and Franzke held a third position in crops. A sixth position was at times held by a soils man--H. Rilling, G. Winright and A. L. Bushey. It was later filled by a crops man.

After the staff expansion during the 1940s and early 1950s the geneology of several crops positions can be clearly traced. J. E. Grafius was succeeded by D. D. Harpstead in 1953, R. Albrechtsen in 1962 and D. L. Reeves in 1970. E. R. Hehn's position was filled by V. A. Dirks in 1947 and D. G. Wells in 1962.

C. J. Franzke's responsibilities in weed control, grass, corn and sorghum breeding were divided among four positions. In weeds, it was E. L. Erickson in 1939, L. A. Derscheid in 1946, J. Stritzke in 1965 and W. E. Arnold in 1970. J. G. Ross became the grass breeder in 1947. K. R. Manke assumed responsibility for corn breeding in 1944 followed by D. B. Shank in 1947 and Z. Wicks in 1980. A. O. Lunden was the sorghum breeder from 1964 until 1976 when the project was discontinued.

E. L. Erickson's responsibilities in the seed laboratory were assumed by N. G. Patterson in 1944, R. C. Kinch in 1947 and A. O. Lunden in 1976. His work with alfalfa was taken over by M. W. Adams in 1947 followed by M. D. Rumbaugh in 1960 and A. A. Boe in 1979.

Soils positions are not so easily traced. After J. G. Hutton died, L. F. Puhr took charge of the soil fertility work in 1940 and F. C. Westin became the soil survey leader in 1947. Westin had several assistants listed in Chapter XXX. Though several others listed in Chapter XXVIII were involved in soil fertility, Puhr's position was not filled when he died in 1962.

The soil analyst position held by H. Loomis, A. L. Bushey, L. F. Puhr and R. Arms became a soil testing position filled by E. J. Williamson in 1947 and P. L. Carson in 1948.

Staff Titles

The practice of using different titles for members of research, teaching and Extension staff members seems to have started before the turn of the century. E. C. Chilcott was listed as Agriculturist in Experiment Station publications and Professor of Geology and Agronomy in several catalogs beginning in 1897-8. After the Agronomy Department was established as a teaching department (1908-9), agronomists had research titles of Assistant in Agronomy, Assistant Agronomist, Associate Agronomist and Agronomist which were comparable to teaching titles of Instructor, Assistant Professor, Associate Professor and Professor of Agronomy. Starting in 1920 Extension specialists had the titles of Assistant Extension Agronomist, Associate Extension Agronomist and Extension Agronomist. During the 1950s these were changed to Extension Agronomist IV, Extension Agronomist III, Extension Agronomist II and Extension Agronomist I. The same systems were used for Extension conservationists and in the 1950s and for Extension soils specialists.

Manley Champlin held three titles from 1917-1918--Associate Professor, Agronomist and Extension Farm Crops Specialist, Lyle A. Derscheid from 1960 to 1963 also had the titles of Professor of Agronomy, Agronomist and Extension Agronomist I.

The Experiment Station titles were discontinued in the 1960s and Extension titles in the late 1970s. Now everyone has a professorial rank.

SPECIALIZATION IN AGRICULTURE

Though the first College catalog listed courses in agriculture, there was no one on the staff to teach them. However, the second catalog listed a course in Practical Agriculture and Luther Foster as Professor of Agriculture, Horticulture and Forestry. It appears that the first courses in agriculture were probably taught in 1886.

Within a short time different programs were listed for Agriculture on the "Divisional" or "College" level, but two decades passed before there was any specialization below that level.

Divisional Specialization

At first all of the agriculture students took essentially the same courses in Practical Agriculture. Starting in 1899 there were three curricula--Practical Agriculture, Scien-

tific Agriculture and Agricultural Engineering (Cat 1898-9). A separate curriculum was included for Agricultural Engineering until 1964, but Practical Agriculture and Scientific Agriculture were soon combined as Agriculture. Then in 1931, curricula were provided for Technical Agriculture and Scientific Agriculture, but the latter was again dropped for 13 years starting in 1946-7.

Separate curricula were listed for pre-forestry from 1938-9 to 1939-40 and Industrial Arts from 1938-9 to 1941-2. Wildlife techniques and conservation was added in 1939-40, General Agriculture in 1945-6 and Agricultural Journalism in 1947-8. A 2-year course in Junior College was included from 1945-6 to 1949-50 and a curriculum in Biochemistry was included from 1946-7 to 1952-3 or 1953-4.

After all these changes, there were still five curricula listed in 1955--Technical Agriculture, General Agriculture, Agricultural Engineering, Wildlife Techniques and Conservation and Agricultural Journalism (Cat 1954-5). Agriculture Science was added in 1959-60 or 1960-1.

The entire system was changed in 1964. A core curriculum was listed for a B.S. degree in Agriculture. In addition to the basic program there were Business, Science and Production or Technical options (Cat 1963-4). The Division of Agriculture became the College of Agriculture and Biological Sciences in 1964. In 1973 there were three core curricula for a B.S. degree in Agriculture, Biological Science and Agricultural Science. The basic program under agriculture continued to include options in Business, Science and Production (Cat 1972-3). In 1974 a curriculum for an Environmental Management major was added (Cat 1973-4). The core curriculum for Agricultural Science was discontinued in 1975 (Cat 1975-6).

Agricultural Groups

From 1909 to 1930 different curricula were suggested for students who wished to specialize in various phases of agriculture. Groups in agronomy, animal husbandry, dairy husbandry and horticulture were listed in every catalog during the 20-year period. Veterinary was listed in 1909-10 but discontinued in a few years.

Agricultural chemistry was included from 1909-10 to 1912-3. Plant pathology and agricultural botany was added in 1909-10 but agricultural botany was dropped in 1912-3. A group in technical training was added in 1917-8.

Several groups were added during the 1920s--agricultural education in 1920-1, farm economics in 1923-4 and farm mechanics in 1926-7.

Majors and Minors

Majors and minors in several departments were authorized in 1931. The 1930-1 catalog stated: "Preferably during the sophomore year, but not later than the beginning of the junior year the student is required to choose, under guidance of the Dean of the Division and the heads of the departments concerned, a major and minor each to consist of subjects in one department or closely related subjects, the major of not less than 24 credit hours nor more than 36 and the minor of not less than 15 credit hours above the freshman year."

Majors and minors could be obtained in several fields in Technical Agriculture and Agriculture-Science. Major fields in Technical Agriculture included Agricultural Economics, Agricultural Education, Agronomy (field crops), Animal Husbandry, Dairy Manufacturing, Dairy Production, Farm Management, Farm Mechanics, Horticulture, Marketing and Soils.

Major fields in Agriculture-Science were Botany, Chemistry, Entomology, Political Science, Rural Journalism and Zoology. Rural Sociology was added a year or two later.

Minor fields in Technical Agriculture were Poultry Husbandry, Rural Sociology and Veterinary Science, while minors in Agriculture-Science could be obtained in Bacteriology, English, Foreign Languages, Mathematics and Plant Pathology. Minors in either program (Technical Agriculture or Agriculture-Science) could be obtained in any of the fields listed as a major in that program except the one chosen for a major.

The Agronomy Department offered majors in Field Crops and Soils until 1942. Only one major, Agronomy, was offered from 1942 until 1950. Then majors were offered in Agronomy, Crops and Agronomy, Soils until 1963 when they were listed as Agronomy Major, Crop Science Option and Agronomy Major, Soil Science Option (Cat 1962-3). Agronomy Major, Technical Option was instituted in 1963 and renamed Agronomy Major, Production Option in 1968.

After the Agronomy Department and Plant Pathology Department were merged in 1969, to form the Plant Science Department, a Plant Science Major was offered in the curriculum for Agriculture, and Plant Pathology majors were offered in the curricula for both Agriculture and Arts and Sciences. The Plant Science Major included a Production Option, Crop Science Option, Irrigation Option, Plant Pathology Option and Soil Science Option (Cat 1969-70).

Three years later majors were offered in Agronomy, Crop Science, Plant Pathology and

Soil Science (Cat 1972-3). An Irrigation Option in the Soil Science Major was offered from 1972-3 to 1976-8.

After entomologists were transferred to the Plant Science Department in 1979, several majors were offered in the Agriculture curriculum--Agronomy, Crop Science, Entomology, Plant Pathology and Soil Science. Under the curriculum for Arts and Sciences, Majors were offered in Entomology and Plant Pathology. A Pest Management Major was also offered (Cat 1980-2).

Advanced Degrees

In 1918 the catalog stated "The degree of Master of Science is conferred upon students who have received the degree Bachelor of Science from this or some other institution offering an equivalent course of study and who in addition, having completed a year of advanced work in residence in accordance with the regulations of the College. Before becoming a candidate for this degree the student's application must be approved by the Committee on Advanced Degrees in accordance with regulations which are issued in a special bulletin, copies of which may be secured from the Registrar" (Cat 1917-8).

Though dozens of M.S. degrees had been conferred prior to 1917, a policy to govern the granting of such degrees was not located in any previous catalogs.

Starting sometime prior to the mid-1940s the requirements for an M.S. degree included 30 quarter hours in the major and 15 in the minor or related fields. Ten hours of the major could be obtained for the thesis.

"The Regents of Education authorized the South Dakota State College to confer the Doctor of Philosophy. Various departments or groups of departments in Plant Sciences, Animal Sciences and Social Sciences will initiate this program of graduate study in 1955-6" (Cat 1954-5).

The first Ph.D. degree at SDSC was granted in Agronomy to A. Earl Foster in 1959. In 1963-4, the Plant Science degree was offered in not only the Agronomy Department, but also Botany and Plant Pathology. In addition, the Agronomy Department had a specific degree for Agronomy. In 1967-8, the Ph.D. in Plant Science disappeared and only specific degrees in Agronomy, Entomology, and Plant Pathology were available. The same was true in 1968-9, but by 1969-70, the same three were offered but no new applicants were being accepted in Plant Pathology. The same situation held true in 1971-2. After 1972-3, only the Ph.D. in Agronomy was available (Brage).

AGRONOMIC COURSES

There were no agriculturally trained instructors on the college faculty in 1884-5. However, the 1885-6 catalog listed Luther Foster as Professor of Agriculture, Horticulture and Forestry and I. H. Orcutt as Professor of Natural Science. Professor of Veterinary Science was a vacant position (Cat. 1885-6).

In 1887-8, C. J. Alloway was listed as Professor of Veterinary Science and Charles Keffer as Professor of Botany (Cat 1878-8). Keffer was more interested in Horticulture and Thomas A. Williams became Professor of Botany in 1891.

Though the number of staff members had increased the number of courses in the 1887-8 catalog was lower than in the previous year.

Practical Agriculture, Crops, Tillage, Drawing, etc. was listed as a course for 1886 and General Agriculture was added in 1892. From that beginning the number of courses increased to 44 in 1960 and 52 in 1970, then decreased.

In 1892 "The second term of the junior year (was) given to the study of soils, fertilizers, history and cultivation of cereal crops, the value of crop rotations, the most approved schemes of rotation, special and local crops, comparison of different branches of agriculture and the general subject of farm economy including the structure, selection and use of farm tools and machinery." The instructor was Luther Foster (Cat 1891-2).

After the first year the course was taught for 3 years to sophomores during the spring and summer terms. The college calendar at that time included a fall term, a long winter vacation, and spring and summer terms.

Ellery Channing Chilcott replaced Foster as Professor of Practical Agriculture in 1893. He taught General Agriculture which was a course in the Agriculture Department. After 1898-9, it was described as "Lectures by Chilcott" (Cat 1898-9). Chilcott left in 1905 and General Agriculture was taught by animal husbandmen J. W. Wilson and H. G. Skinner. For one year (1904-5) it was described as "How plants grow, preparation of seedbed, cultivation, harvesting marketing, etc.". Then it was described as Lectures by Wilson and Skinner and discontinued around 1908.

In the meantime courses of interest to Agronomy were taught in other departments. In the Botany Department, courses were taught in General Botany, Taxonomy, Mycology and Ento-

mology. Williams was replaced by DeAlton Saunders in 1895. Saunders added a course entitled Grasses and Seeds which was "a study of seeds of injurious plants, their means of distribution and destruction of same. Also, a study of economic grasses, their distribution and structure" (Cat 1900-1). Saunder's successor, William A. Wheeler, in 1904 changed the course to Grasses and Forage Crops--"A systematic study of grasses and legumes. Laboratory work upon plants used for forage" (Cat 1904-5).

Keffer was replaced by N. E. Hansen in 1895. In 1898-9 Hansen added a course entitled Evolution of Plants which no doubt included information about agronomic crops.

Agronomy Courses 1898-1911

The Department of Geology and Agronomy was formed in 1898. E. C. Chilcott, Professor of Geology and Agronomy, taught all five courses in the department. He also taught General Agriculture (Cat 1898-9).

Four years later the departmental name was changed to Geology, Agronomy and Agricultural Physics, and the title of the course Soil Physics was changed to Agricultural Physics. The staff included Professor Chilcott and Instructor Holm (Cat 1901-2). A. B. Holm had been listed earlier by the Experiment Station as Assistant in Agricultural Physics.

<u>1897-8</u>	<u>1901-2</u>	<u>1905-6</u>	<u>1908-9</u>
1. Elementary Geology	1. Elementary Geology	1-2 Geology	1. Farm Crops
2. Soil Physics	2. Agr. Physics		2. Farm Crops
3. Soil Fertility	3. Soil Fertility		3. Farm Crops
4. Geology	4. Geology		4. Soils
5. Agr. Experimentation	5. Agr. Experimentation*		5. Soils
	6. Farm Crops**		6. Geology
	7. Farm Mechanics**		7. Farm Mechanics
	8. Minerology**		8. Farm Management
	9. Meteorology**		9. Dairy Lectures
			10. Invest. & Thesis
			Advanced Crops ^x
			Soils ^x
			Soils ^x

*Discontinued in 1903-4
 **Added in 1903-4
^xAdded in 1909-10

Holm was replaced by John S. Cole in 1903. The next year Agricultural Experimentation was deleted and four courses were added (Cat 1903-4). As an undergraduate, Cole had served as Special Agent to the USDA in the Experiment Station since 1901. He graduated in 1903 and was named to the teaching staff.

Farm Crops, taught by Cole, was described as "The classification, improvement, culture, harvesting, uses, history and geographical distribution of crops." Laboratory work was "with grain grading, cleaning and testing and corn judging."

Chilcott left in 1905 and Cole was the only instructor in the Department of Geology, Agronomy and Agricultural Physics.

The department ceased to exist in 1906 and the courses formerly taught by the department were not offered. In its place was the Department of Geology. Professor Robert L. Slagle taught two courses in Geology to students in General Science, Civil Engineering and the agronomy, animal husbandry and horticulture groups in Agriculture (Cat 1905-6).

Slagle, who had been Professor of Chemistry at SDAC from 1895 to 1897 and President of

South Dakota School of Mines from 1899 to 1905, became President of South Dakota Agricultural College on January 1, 1906 (K-53).

For 3 years the catalogs stated: "In offering the work of this (Geology) department, two objects are sought. First, to give all candidates for a B.S. degree a thorough understanding of the foundation principles of the subject. Second, to afford an opportunity for students desiring to become specialists along any line of agriculture to make a thorough study of the soil (and) its relation to plant growth and crop production. The basis of all the work is Physical Geography which is required as a preparatory study. Especial effort is made . . . to acquaint them (students) with geological history, climatic conditions and natural resources of the state ..."

During this period the college calendar was changed from the quarter to semester system.

Cole left SDSC in 1908 and the new staff included Professor Clifford Willis and Instructors J. V. Bopp and H. J. Besley. Ten courses

were listed in the Department of Agronomy (Cat 1908-9). The Department of Agronomy had been recognized by the Experiment Station since 1903 (Cir 123). Now it became a teaching department.

"The aim of the Agronomy Department (was) to give the student some knowledge of the origin and formation of the soil, physical properties of the soil, supply of food to the growing plant, soil moisture, soil temperature, tillage, nutrition, capillary and water holding capacity of various soils, the effect of mulching and tillage upon conservation of moisture. Also the classifications, improvements, culture, harvesting, uses, history and geographical description of crops" (Cat 1908-9).

One course of Farm Crops was required during the junior year for students in agronomy, animal husbandry and horticulture and two courses were required of agronomy seniors. Two courses of Soils, with prerequisites of physics and chemistry, were taught to agronomy juniors and horticulture seniors; and one course each in Farm Mechanics and Farm Management to seniors in agronomy, animal husbandry and horticulture. Geology was required of seniors in the three agricultural groups and civil engineers and was an elective for General Sciences. Other courses included Dairy Lectures and Investigations and thesis. Dairy Lectures was a course in crops and soils taught to students in the creamery short course (Cat 1908-9).

Two courses of Soils and Advanced Crops were added for seniors for 1910 and Farm Mechanics became Farm Machinery. The three Farm Crops courses became sophomore courses. Crop judging was required, while forage crops and weeds and seeds were electives.

The four Soils courses were in soil genesis, soil physics, soil fertility required for juniors and advanced soils, an elective for seniors.

Geology, Farm Management and Thesis were required of seniors while Farm Machinery and Advanced Farm Crops were electives for juniors and seniors, respectively (Cat 1909-10).

The School Agriculture Bulletin in July 1909 described the agronomy courses taught by J. V. Bopp in the newly established School of Agriculture.

"Farm Crops are studied throughout the first year. Seed selection is the leading branch of work. Very thorough training is given in the agronomy laboratory in score card study of wheat, oats, barley, rye, emmer, corn, grasses, clovers, alfalfas, etc."

"Soil & Origin: The student seeks to understand the origin of soils, their gradual forming and bringing into condition for farming purposes, their means of deterioration and improvement."

"Land Management: In the third year the student studies the science and practice of land management, the problem of fertility, the principles and best systems of rotation of crops, the conservation of soil resources, the economics of crop production and the labor question."

These course descriptions were not altered materially for more than a decade.

Agronomy Courses 1912-1931

Besley was replaced by Howard Loomis in 1910 and Willis and Bopp by Albert Nash Hume and Joseph Gladden Hutton in 1911. Manley Champlin was added to the staff in 1912.

The number of courses was reduced to ten in 1912 and the number of credit hours increased for most crops courses. Farm Crops I (grain judging, seed testing, weeds) and Farm Crops 2 (crop breeding) were required of sophomores. Soil Physics and Management 4 and Soil Fertility 5 were required of juniors and Advanced Crop Problems 3 was a special problems elective. Graduate courses were special problems courses. Dairy Lectures was for the Creamery Short Course. Other courses, including Advanced Soil Fertility added in 1913, were electives mostly for seniors (Cat 1911-2 and 1912-3).

Another major change in course offerings took place in 1917--14 courses for undergraduates, 1 for the Creamery Short Course, were listed along with graduate courses (Cat 19167). Starting 3 years later the names of instructors for each course were listed. Hume taught Crop Breeding. Champlin taught Grain and Root Crops, Field Management, and Crop Inspection (Advanced Grain and Root Crops) and assisted Hume with Field Crops, a problems course for advanced students. Fowlds taught Seed Inspection (Cat 1919-20). A. T. Evans took over Champlin's courses in 1921 (Cat 1920-1).

Hutton taught Earth Science; Geology and Earth Science; Meteorology. Alfred L. Bushey, who replaced Loomis, taught Soil Physics and Management, Soil Fertility and Irrigation and Drainage. They collaborated with Advanced Soil Fertility and Advanced Soil Physics (Cat 1919-20).

At this time the college calendar returned to the quarter system and several 4-hour courses were changed to 2-term, 3-hour courses.

Field Crops was changed to a 2-term 3-hour

course in 1920 and Soil Fertility and Soil Physics were replaced by Soil Survey and Experimental Field Observations (Cat 1919-20). Soil Seminar was added in 1923 (Cat 1922-3).

In 1931 when the system of majors and

minors was instituted, the list of courses provided by the Agronomy Department underwent another major revision. A new numbering system was used, courses were added, and they were grouped under the headings of Field Crops, Soils and Earth Sciences (Cat 1930-1).

<u>1911-2</u>	<u>1916-7</u>	<u>1930-1</u>
1. Farm Crops (5) F 2. Farm Crops (5) S 3. Adv. Farm Crops (5-10) 4. Soil Physics & Mgmt. (5) F 5. Soil Fertility (5) S 6. Adv. Soil Phys.* (5) F 7. Adv. Soil Fert.* (5) S 8. Dairy Lectures 9. Earth Sci; Geology (5) F 10. Earth Sci; Meteorology (3) S Graduate Courses Adv. Soil Fertility*	1. Grain & Root Crops (4) F 2. Crop Breeding (3) S 3. Field Management (2) S 4. Forage Crops (4) S 5. Seed Inspection (2) S 6. Field Crops (4-8) 7. Crop Inspection (2) S 8. Soil Physics & Mgmt. (4) S** 9. Soil Fertility (4) S** 10. Adv. Soil Physics (4) F 11. Adv. Soil Fert. (4) S 12. Irrig. & Drainage (2) S 13. Earth Sci; Geology (5) F 14. Earth Sci; Meteorology (3-5) 15. Field Crops (Dairy) Graduate Courses	<u>Field Crops</u> 1. Field Crops (5) W 20. Forage Crops (3) S 40. Seed Inspection (3) F 41. Crop Path; Crop Inspect. (3) 42. Crop Breeding (3) W 60. Crop Ecology (3) F 61abc Crop Problems (3) FWS 62. Exp. Field Observations <u>Soils</u> 50abc Soils (4) FWS h 70 Adv. Soil Physics (4)*** h 70 Adv. Soil Fertility (4)*** h 72 Irrig. & Drainage (3)*** h 73 Soil Surveying (2) S h 74 Soil Field Trip (3) h 75 Soils Seminar (1) <u>Earth Sciences</u> 1. Physiography (4) S 51. Geology (5) S 52. Meteorology (4) F 53. Physical Geography (4) W

*Added in 1912-3

**Deleted in 1920-1

***Taken by arrangement with instructor

Agronomy Courses 1930-1955

The second major revision in 2 years occurred in 1932. Courses were still divided into three groups to more or less coincide with the majors in Agronomy (Field Crops) and Soils that were authorized (Cat 1932-3). Five years later Crops Seminar 161abc (1) FWS and Soil Conservation Methods 158 (3) were added and two courses were changed. Elements of Geology 30 (4) S replaced Geology 71 and Geology 171 (5) S replaced Historical Geology 171 (Cat 1937-8). This is the list of courses that appeared in the catalog when we enrolled at SDSC in 1939. However, the list we remember was that of 1939-40.

In 1942 freshman and sophomores were grouped into the Junior College while upper classmen were in the Senior College. Courses in each group (Farm Crops, Soils and Earth Sciences) were further subdivided for Junior College and Senior College. Grain Crops and Crop Ecology were discontinued; Seed Technology replaced Seed Inspection and Soils 151abc became Soils

25ab in the Junior College and Soils 151 in Senior College. Crops and Soils Seminars were combined under Agronomy Seminar and separate majors of Field Crops and Soils were replaced with a major in Agronomy (Cat 1941-2).

The list of courses was revised again in 1946. It was no longer divided into groups for Field Crops, Soils and Earth Sciences, but was divided for Junior College, Senior College and Advanced Students (mostly graduate students (Cat 1945-6). Under the leadership of Wallace W. Worzella, who became Head of Agronomy in 1943, the soils and crops courses were integrated for a single department and a single major.

In 1947 Crop Production 1 (5) F was changed to a 2-quarter course Crop Production lab (3) FW (Cat 1946-7). Separation of courses for Junior College and Senior College was discontinued in 1948 when this system was dropped (Cat 1947-8).

As staff size enlarged in the late 1940s and early 1950s the number of courses offered

increased. Irrigation, Crops and Soils Production 170 (3) W and Advanced Plant Genetics 206 (3) were added in 1949. Meteorology was discontinued and Geology was dropped for one year (Cat 1948-9).

Through two majors (Agronomy, Crops Major and Agronomy, Soils Major) were obtainable in 1950 there was no major change in the list of courses. Several courses were renumbered and they were regrouped. Courses with numbers 1

to 49 were in the Lower Division, while numbers of 50 to 99 were in the Upper Division and 200 numbers were in the Graduate Division. Grain Grading and Identification 38 (3) S, Cytogenetics of Field Crops 207 (3) S and Methods of Soil Research 215 (3) S were added in 1959. Crop Judging 52 (2) FS was changed to a 3-hour spring quarter course and Research in Agronomy 299 was changed to Thesis in Agronomy 299 (Cat 1949-50). General Physical Geography was dropped in 1951 (Cat 1950-1).

<u>1932-3</u>	<u>1939-40</u>	<u>1945-6</u>
<u>Field Crops</u>	<u>Field Crops</u>	<u>Junior College</u>
1 Field Crops (5) W	1 Field Crops (4) W	1 Crop Production (5) W
20 Forage Crops (3) S	20 Forage Crops (3) S	25ab Soils (3) FW
40 Seed Inspection (3) F	30 Grain Crops (3) S	30 Seeds & Weeds (3) F
41 Crop Path. & Insp. (3) F	40 Seed Inspection (3) F	
142a Crop Breeding (3) F	142a Crop Breeding I (3) F	<u>Senior College</u>
142b Crop Breeding (3) W	142b Crop Breeding II (3) W	50 Seed Technology (3) W
142c Crop Breeding (3) S	142c Crop Breeding III (3) S	55 Grain Crops (3) W
160 Crop Ecology (3) W	160 Crop Ecology (3) S	58 Crop Judging (2) F
261 Crop Prob. & Res. (3)*	161abc Crop Seminar (1) FWS	74 Soil Mgmt. & Fert. (3) F
	201 Biometry (3) F	75 Soil Prob. on Dryland (2) S
<u>Soils</u>	261 Crop Prob. & Res. (3) *	78 Soil Conservation (3) S
151abc Soils (4) FWS	<u>Soils</u>	142 Plant Breeding (3) S
152abc Adv. Soils (4) FWS	151abc Soils (4) FWS	150 Lab Meth. Soil Inves. (4) S
153 Irrig. & Drain (3)*	152abc Adv. Soils (4) FWS	160 Soil Survey (2) S
154 Great Soil Groups (3)*	154 Great Soil Groups (3)*	162 Range & Pasture (3) S
155 Soil Sur. & Land Class (2)*	155 Soil Survey & Class (2)*	171 Geology (4) S
156 Soils Field Trips (3)*	156 Soils Field Trips (3)*	172 Soil Physics (3) W
157abc Soils Seminar (1) FWS	157abc Soils Seminar (1) FWS	180 Crop Ecology (2) W
251 Soils Research (12-20)*	251 Soils Research (12-20)*	181 Meteorology (3) W
<u>Earth Sciences</u>	<u>Earth Sciences</u>	182 Biometry (3) S
71 Geology (4) S	171 Geology (5) S	190 Crop Prod. Prob. (2) W
171 Historical Geol. (5) S	172 Meteorology (4) W	191 Gen. Phys. Geog. (5) F
172 Meteorology (4) W	175 Phys. Geography (5) F	192 Soil Problems (2) W
271 Climatology (3) S		199abc Agronomy Seminar (1) FWS
272 Phys. Geography (5) F		<u>Advanced Students</u>
		205 Adv. Crop Breed. (3)*
		210 Adv. Crop Prod. (3)*
		220 Adv. Soil Prob. (3)*
		230 Adv. Soil Fert. (3)*
		290 Res. in Agron. (2-5)*

*Taken by arrangement with instructor

Agronomy Courses in 1955-1979

The course list was revised again in 1955. About a dozen courses were added in the Graduate Division to prepare for the Ph.D. degree program that would start in 1955-6 (Cat 1954-5).

Several other changes occurred during the next decade. Principles of Plant Genetics was renamed Advanced Plant Genetics in 1957 and a Soil Minerology number was changed from 284 to 184 which moved it from the Graduate Division

to the Upper Division (Cat 1956-7). The next year Crop Production Problems 190-191 was added for the Upper Division and Range and Pasture Management was renamed Pasture Management (Cat 1957-8). In 1960 Crop Judging and Soil Morphology were discontinued; and Principles of Plant Breeding became Advanced Plant Breeding (Cat 1959-60).

Changing the college calendar from quarters to semesters necessitated another revision in 1964. Lower Division and Upper Division courses were grouped in the Undergraduate Division

and a new numbering system was instituted. Courses with numbers in the 100s were normally taken by freshmen, 200s by sophomores, 300s by juniors and 400s by seniors. Courses in the 600s and 700s were for graduate students, but seniors could enroll in those with a 600 number (Cat 1963-4).

In 1968 the course numbers were changed for two courses--Biometry to 614 and Advanced Weed

Physiology and Control to 663 (Cat 1967-8).

When the Agronomy and Plant Pathology Departments were merged into the Plant Science Department, the list of courses for the new department included 34 courses from Agronomy and 18 from Plant Pathology (Cat 1969-70). The merger was so sudden that there was not enough time to reorganize the list of courses. It was done, however, in 1971. By consoli-

<u>1954-5</u>	<u>1963-4</u>	<u>1970-1</u>
<u>Lower Division</u>	<u>Undergraduate Courses</u>	<u>Undergraduate Courses</u>
1-2 Crop Breeding (3) FW	103 Crop Production (3) FS	103 Crop Production (3) FS
25-26 Soils (3) FW	213 Soils (3) FS	113 Soils (3) FS
30 Weed Control (3) F	233 Weed Control (3) F	223 Prin. of Pl. Path. I (3) F
38 Grain Grad. & Ident. (3) S	243 Geology (3) S	233 Weed Control (3) F
	303 Seed Technology (3) S	234 Geology (3) S
<u>Upper Division</u>	312 Seed Prod. & Process. (2) F	303 Seed & Grain Tech. (3) S
50 Seed Technology (3) S	313 Forage Crops & Pastures (3)	310 Soil Morph. Gen. & Class. (3)
52 Crop Judging (3) F	323 Soil Mgmt. & Fert. (3) F	312 Grain & Seed Prod. & Proc.
55 Grain Crops (3) S	343 Grain Crops (3) F	313 Forage Crops & Pastures (3) F
56 Forage Crops (3) W	372 Soil Conservation (2) F	323 Soil Fert. & Fertilizer (3) F
57 Soil Conservation (3) S	414 Soil Genesis, Class. & Sur.	333 Prin. of Pl. Path. II (3) S
58 Soil Mgmt. & Fert. (3) S	422 Crop Breeding (2) F	352 Phys. Environ. of Soil & Pl.
75 Soil Prob. on Dryland (2)*	432 Crop Ecol. & Phys. (2) S	372 Cons. & Mgmt. of Soil (2) F
142 Plant Breeding (3) W	443 Soil Chemistry (3) F	412 Soil Chemistry (2) S
150 Lab. Meth. & Soil Inv. (4)*	452 Soil Physics (2) S	443 Plant Breeding (3) F
152 Class. & Gen. of Soils (3)	462 Soil Morphology (2) S	453 Mycology (3) F
160 Soil Survey (3) S	483 Irrig, Crops & Soil Pract.	483 Irrig--Crop & Soil Pract. (3)
162 Range & Past. Mgmt. (3) S	490 Crops & Soils Prob. (1-2)	490 Special Problems (1 or 2)
170 Irrig. Crop & Soil Pract.	491 Seminar (1) FS	491 Seminar (1) FS
171 Geology (3) S	<u>Graduate Courses</u>	<u>Graduate Courses</u>
172 Soil Physics (3) W	613 Biometry (3) F	604 Adv. Pl. Path. I (4) F
180 Crop Ecology (2) S	633 Adv. Genetics (3) F	613 Adv. Pl. Path. II (3) S
182 Biometry (3) W	672 Soil Minerology (2) F	614 Biometry (4) F
190-1 Crop Prod. Prob. (2) FW	703 Cytology (3) S	643 Phys. Prop. of Soils (3) F
192-3 Soil Prob. (2) FW	713 Cytogenetics (3) S	654 Chem. Prop. of Soils (4) F
197-9 Agron. Seminar (1) FWS	723 Adv. Plant Breed. (3) S	663 Environ. & Phys. Aspects of Crop Prod. (3) F
<u>Graduate Division</u>	742 Adv. Soil Fert. (2) S	673 Adv. Gen. & Cytogen. (3) S
205 Prin. of Plant Breed. (3)	743 Adv. Soil Physics (3) F	700 Special Topics (1-6)
206 Adv. Plant Gen. (3)	753 Adv. Soil Chem. (3) S	780 Adv. Spec. Prob. (1 or 2)
207 Cytogen. of Crops (3)	763 Adv. Weed Phys. etc (3) F	781 Pl. Sci. Seminar (1) FS
210-1 Adv. Crop Prod. (3) F	772 Adv. Soil Morph. etc. (2) S	790 Thesis
215 Metho. in Soil Res. (3) S	773 Design & Anal. of Exp. (3)	
220 Adv. Soil Prob. (3)*	780 Adv. Soil Prob. (1 or 2)	
230 Adv. Soil Test (3)*	781 Agron. Seminar (1) FS	
235 Cytology (3)*	790 Thesis	
240 Adv. Weed Control (3) W*		
250 Adv. Soil Physics (3)*		
255 Soil Colloids (3)*		
272 Adv. Soil Morph. & Gen (3)		
275 Res Meth. in Agron. (3) W		
280 Adv. Crop Prob. (3)*		
282 Stat. Theory in Biol. (3)		
284 Soil Minerology (3)		
296-8 Seminar (1)		
299 Thesis in Agron. (7-10)		

*Course taken by arrangement with instructor

dating numerous courses, the list was reduced to 30 even though two courses concerning physical and environmental effects on soils and crops were added (Cat 1970-1). The next year Soil Chemistry 412 (2) S and Advanced Plant Pathology I 604 (4) F were added (Cat 1971-2).

Biometry was transferred to another department in 1975. Thesis Ph.D. 890 was added in Plant Science and Thesis 790 became Thesis M.S. 790 (Cat 1974-5). Several course numbers were changed in 1976. Plant Breeding was changed to 433 and all 600 numbers also carried the corresponding 500 number. For example, course 604 was now 504-604 (Cat 1975-6). The course number for Geology was changed from 234 to 243.

Five courses were added in 1979--Field Application of Pesticides (3) S, Crop Judging 320 (1 or 2) FS, Soil Judging 321 (1) FS, Environment and Plant Health 322 (2) S and Internship in Plant Science 472 (1-12) (Cat 1978-80).

Also in 1979 entomologists were transferred to the Plant Science Department. Several graduate courses and 15 undergraduate courses were added to those of the Plant Science Department. However, they were not integrated with previous courses, because all courses were grouped for the five majors--Agronomy, Crop Science, Entomology, Plant Pathology and Soil Science (Cat 1978-80).

CURRICULA

The curriculum varied with the number of available courses which was dependent on the number and expertise of the faculty.

When the College opened on September 24, 1884, there were four professors. President George Lilly, who was supposed to teach Mathematics and Engineering, and William Phillips, Professor of Literature and Science of Languages, were paid for their services. Two others who donated their time were C. A. Kelsey, a local physician, who taught Natural Sciences and "Professor" Parker who taught vocal music (S-13).

The first catalog listed four courses of study--Agriculture, General Scientific courses, General Engineering and Mechanical Engineering. Under Agriculture were included such topics as fertility, field crops, tillage and soils. The student was expected to write a thesis as part of the B.S. requirement (Brage).

It also stated: "Post-graduate courses will be arranged in the higher subjects; on completing the courses, the higher degree will be given" (Brage).

The program in Agriculture led to the degree Bachelor of Scientific Agriculture for Young Men. The candidates had to be at least 14 years old and pass exams in all primary areas such as arithmetic, English and so forth (Brage).

If a student did not meet these qualifications, the college had a preparatory department available to them. "To enter the preparatory department, the student must be no less than 12 years of age and be able to intelligently render specimens of the grade of Swinton's Fifth Reader and Speaker, to spell ordinary words of the fifth grade reader, to read and write numbers with ease and facility, and must be thoroughly acquainted with the four fundamentals of Arithmetic: addition, subtraction, multiplication, division. Students attending preparatory school and after passing accreditable examinations in it's studies will be entitled to admittance to the college" (Brage).

Tuition was free to South Dakota students and \$8.00 a year for out of state students. Board and room was available in private homes and ranged from \$3.50 to \$4.00 per week (Brage).

Though there were no teachers for agriculture, the first catalog written late in the year stated: "The student in Agriculture gives most of his time to Agriculture, Geology, Botany and Farm Work." Lengthy descriptions were given for courses entitled Agriculture, Horticulture, Forestry, Landscape Gardening, Veterinary Science, Natural Science (botany, elementary chemistry, analytical chemistry, minerology, geology and zoology) and Agricultural Chemistry.

1886-1898

The course in Agriculture leading to a degree in Scientific Agriculture was designed "to furnish a broad and thoroughly practical education to fit young men for all pursuits of life. Its special object ... a thorough preparation in the various agricultural industries, giving practical knowledge in agriculture, horticulture, forestry, landscape gardening, farm superintending, farm economy, dairying, stock breeding, cattle feeding and veterinary science (Cat 1885-6).

The preservation of health and the cultivation of a taste for agricultural pursuits were two important objects. To accomplish the objects of this institution, it was evident that the student must not, in acquiring a scientific education, lose either the ability or the disposition to labor on the farm. If the farmers were to be educated they must be educated on the farm itself. The college would afford its

students the benefits of daily labor, sufficient for experimental purposes, and to foster a taste for agricultural pursuits. Labor in which the work done accrued to the benefit of the college and not to the benefit of the student, such as all operations in the workshop, garden, upon the farm and elsewhere, was credited to the student to help pay his expenses (Cat 1885-6).

The College Farm consisted of 80 acres of excellent land, all of which was broken and a part in cultivation. All of the farm would not be in good working condition for experimental work for the promotion of agriculture and horticulture until the spring of 1886, at which time, actual work would be commenced under the direction of the Professor of Agriculture (Cat 1885-6).

In 1886, when there was a Professor of Agriculture and a Professor of Natural Sciences on the staff, the agricultural curriculum during the freshman year included History, Description and Practical Management of Livestock for 2 hours a week during the fall term, Practical Agriculture, Crops, Tillage, Drawing, etc. for 2 hours each week of the winter term and three 2-hour courses in Practical Horticulture, Dairying and Elementary Botany during the spring term.

The next year they would take Botany (2 hours), Chemistry (3 hours) and Laboratory Chemistry (2 hours) each term as well as Horticulture (2 hours) during the fall, and Entomology (2 hours) during the winter and spring.

When they reached the junior year they would be expected to take 2-hour fall-term courses of Stock Feeding, Horticulture, Chemistry Laboratory Work, and Land Surveying; winter-term courses of Stock Feeding (2 hours), Agricultural Chemistry (2 hours), Entomology (5 hours); and spring term courses of Horticulture (3 hours), Landscape Gardening (1 hour) and Zoology (5 hours).

Senior courses included Grasses, Forage Plants and Manures (3 hours), Veterinary Sciences (3 hours) and Geology and Mineralogy (5 hours) during the fall; Veterinary Sciences (5 hours) during the winter; and Experimental Agriculture (5 hours) during the last term (Cat 1886-7).

The agricultural staff was doubled in 1887-8 with the addition of a veterinarian and a botanist-horticulturist, but the number of courses in the catalog was reduced to a more realistic number. They included one quarter each of botany and Agriculture for freshmen; botany and horticulture for sophomores; two courses each in chemistry and geology, one

course each in entomology, horticulture, stock feeding, agriculture and forestry for juniors; and one course each in landscape gardening, stock breeding and dairying, geology, practical forestry, laboratory work in entomology and two courses in veterinary science for seniors (Cat 1887-8).

The typical degree in agriculture in the 1890s included 6 courses in mathematics, 7 in English, 6 in basic and applied chemistry, 2 in military, 4 in basic and applied physics, 6 in biological areas, 6 in social science, 1 in entomology, 1 in soil fertility, 4 in animal sciences, and others in various areas (Brage).

As stated in the 1894 catalog, the expenses for study need not exceed \$120 per year and it was also mentioned that many students could earn as much as \$2.00 a week during the work season (Brage).

A year later it was stated that "the labor done by students was of two kinds, educational and paid. All labor done in the shops, on the farm, in the garden or laboratories for the sake of learning was educational and not paid for.

"Students who wished to work for pay were to register at the president's office at the beginning of the term *** The usual hours were from 3 to 5 p.m. The regular rate of wages was 10 cents an hour (Cat 1894-5).

"A large amount of remunerative labor was available in the Experiment Station during the spring, summer and fall. Many students were able to earn nearly enough to pay their board."

By the arrangement of the college calendar into fall, spring and summer terms it was stated that a student could work his way through college with the aid of what he could earn during term time and what he could earn teaching school during the long winter vacation from November 5 to February 21 (Cat 1894-5).

Tuition and incidental expenses were listed as \$3.00 per term, board and room \$3.00 to \$3.50 per week and text books at cost.

1900-1930

In 1899 the schedule for practical agriculture indicated that Freshmen took two courses each in Chemistry, Geometry, Botany and Advanced Rhetoric; one course each in Organic Chemistry, Trigonometry, Horticulture and American Literature; and a year of Military.

Sophomores took Soil Physics, Elementary Geology in the fall; Botany, Chemistry of Food

and Shakespeare in the winter; Entomology and Advanced Physiology in the spring; fall and winter courses of General History and a year of Military.

Junior courses included Advanced Geology, Agricultural Chemistry and Theories of Horticulture in the fall; American History, Stock Feeding and either Soil Fertility or Evolution of Plants in the winter; Stock Feeding, Astronomy, and Forestry or Landscape Gardening in the spring; and Oratory all three terms.

Seniors had courses in Constitutional Law, Elementary Psychology and Veterinary Medicine during the fall term; Agricultural Experiments, Economic Theory and Equipment for Stock Farms the second term; and Bacteriology, General Agriculture, Horticultural Experimentation and Ethics in the spring (Cat 1898-9).

During the first year of the Agronomy Department the curriculum included two semesters each of Rhetoric and Military and one semester each of Plane Geometry, Stock Judging, Land Surveying and Breeds of Livestock. Sophomore courses included two semesters each of General Botany, General Zoology and Physiology, and Military and one semester each of Quantitative Chemistry, Agricultural Chemistry and Genetics. French and German were listed as electives for both freshmen and sophomores.

Juniors had two semesters of Structures and Styles and one semester each of Medieval History, Psychology, General Physics, Modern History and Ethics. Those in the Agronomy group had two semesters of Soils and one of Farm Crops.

Seniors in the Agronomy group studied Political Economy, Geology, Advanced Botany, Stock Feeding and Farm Crops the first semester and Sociology, Farm Management, Farm Mechanics, Entomology and a third course in Farm Crops during the spring semester (Cat 1908-9).

In 1924 the Agriculture Division and General Science Division were organized (Cat 1923-4). The divisions of Engineering, Home Economics and Pharmacy were added the next year (Cat 1924-5).

Freshmen then took three quarters of Rhetoric, Military and Inorganic Chemistry; two courses of General Botany and General Survey; Stock Judging in the fall, Grain and Root Crops in the winter; and Farm Dairying and Mathematics in the spring for a total of 51 hours.

Sophomores took three quarters of American Literature, Military and Extemporaneous Speaking; fall and winter courses of General Zoology; fall courses of Elementary Organic Chemistry, General Poultry, and General Horticulture; Winter courses of Quantitative Analysis, Veterinary Anatomy and Physiology and General Bacteriology; spring courses of U.S. History and Farm Mechanics; and three hours of electives in the spring for a total of 50 credit hours.

Agronomy juniors were scheduled to take three quarters of Soils; winter and spring courses of Crop Breeding; fall courses of Seed Inspection, General Economics; spring courses of General Entomology and Agricultural Economics; and 15 hours of electives for a total of 51 credit hours.

The curriculum for seniors included Animal Nutrition in the fall; Meteorology in the winter; Geology and Forage Crops in the spring and 36 hours of electives for a total of 51 credit hours (Cat 1923-4).

1931-1964

The practice of offering majors and minors was instituted in 1931. Then the Technical Agriculture curriculum for freshman included Rhetoric FWS, Military FWS, Inorganic Chemistry FWS, General Botany FW, General Survey F, Types and Classes of Livestock F, Field Crops W, Mathematics S and Farm Dairying S.

Sophomores took American or English Literature FWS, Military FWS, Extemporaneous Speaking FWS, General Zoology FW, Elementary Organic Chemistry F, Principles of Economics F, Quantitative Analysis W, General Bacteriology W, General Anatomy and Physiology S, General Horticulture S, Farm Machinery S, Graphic Methods S and 3 hours of electives S.

Juniors took Soils FW, Animal Nutrition F, Principles of Sociology F, General Poultry F, Production Economics W, Agricultural Entomology S, and 23 hours of electives.

Senior courses included Genetics F, Agricultural Economics S and 44 hours of electives (Cat 1930-1).

Extemporaneous Speaking and Genetics were omitted the next year and General Poultry became a sophomore course (Cat 1932-3).

A major in Farm Crops could be obtained if sophomores took Forage Crops S; juniors took Seed Inspection F, Crop Pathology and Crop Inspection F, Crop Breeding F, Meteorology F, and Geology S; and seniors took

Crop Ecology F, Crop Problems S and Experimental Field Observations F for a total of 29 credit hours.

For a Soils major, juniors took Soils FWS and seniors took Advanced soils F, Meteorology F, Geology S and Soils Seminar FWS for 18 hours (Cat 1930-1).

The depression years of the 1930s had a profound effect upon students in general. In the 1935-6 school year the yearly cost for a student was tuition \$70.00, board and room \$225.00, health fee \$7.50, lab fees \$15.00, books and supplies, \$30.00, student association fee \$15.75, and library fee \$3.00 for a total of \$366.25 (Brage).

The list of courses was revised in 1940. At that time a major in Field Crops could be obtained by taking Field Crops the freshman year; Forage Crops the sophomore year; Crop Pathology and Crop Inspection, Seed Inspection, Crop Breeding 142a, Crop Breeding 142b, Biometry, Geology and Meteorology the junior year; and Crop Ecology and 3 hours of Crop Problems and Research the senior year.

Freshman took a year of English Composition, Inorganic Chemistry, Military and Physical Education; fall-winter courses of General Botany and Orientation; Market classes of Livestock in the fall; Crop Production in the winter; and General Horticulture and College Algebra in the spring for a total of 54 credit hours. Crop Production became a fall-winter course the next year and raised the total to 56 hours.

Sophomores took a year of Physical Education and Military; a fall-winter course of Soils; fall courses of Elementary Organic Chemistry, Advanced Composition and Seed Problems and Weed Control; winter courses of Gravimetric Analysis, Publicity Methods, Field Crop Entomology and General Bacteriology and spring courses of Extemporaneous Speaking, Agricultural Engineering, Principles of Agricultural Economics and Elements of Dairying for a total of 55 credit hours.

Juniors took Genetics, Elementary Psychology and General Plant Physiology in the fall; Livestock Feeding, Pathology of Crops and Grain Crops during the winter; Geology, Biometry and Soil Management and Fertility in the spring; and 22 hours of electives for a total of 54 credit hours.

Seniors took fall courses of Elementary Physics, Classification and Genesis of Soils, and Principles of Sociology; winter courses of Forage Crops, and Crop Ecology; a spring

course of Soil Conservation; three terms of Agronomy Seminar and 31 hours of electives for a total of 54 credit hours (Cat 1945-6).

When the department in 1951 again began granting separate degrees in Crops and Soils, there were few differences in the curricula. The Crops Major included Plant Breeding while the Soils Major included Laboratory Methods or Soil Physics, Geology and Classification and Genesis of Soils. The Soils Major allowed for fewer electives (Cat 1950-1).

1965-1980

The curriculum in the mid-1960s for an Agronomy Major included English, Inorganic Chemistry, Qualitative Analysis, Algebra, Plane Trigonometry, Crop Production, Orientation, Physical Education, Military and an elective.

Sophomores studied General Botany, Military, Soils, Advanced Exposition, Fundamentals of Speech, Introduction to Sociology, Elementary Organic Chemistry, Principles of Economics and Animal nutrition.

Juniors were required to take Genetics, Introductory Physics, Government, Plant Physiology, General Bacteriology six hours of Social Science electives, and 4 hours of Humanities electives.

Seniors took Agronomy Seminar and unrestricted electives.

Options to the Agronomy Major were added in 1963. The technical option was for students interested in the Production and Industry area of Agronomy (Crops and Soils) preparing for work in the production aspects such as farming, ranching; governmental work, such as County Agent, Farm and Home Administration, Soil Conservation Service, Commodity Credit Corporation, etc., or in the processing or sales with a commercial concern such as seed buying, fertilizer sales, elevator manager, etc., should choose the technical option (Cat 1962-3).

A Crop Science option was offered for students interested in an intense study of applied plant science. In addition to courses listed in the Agronomy Major the student took courses in Plant Breeding, Quantitative Analysis, Plant Pathology, six additional hours of Chemistry and six of Mathematics and/or Physics (Cat 1962-3).

The Soil Science option met the requirements developed by the Soil Science of America. In addition to the courses listed

for the Agronomy Major, a student took Geology, Quantitative Analysis, six additional hours in chemistry, six in Mathematics and six in Physics (Cat. 1962-3).

During the 1970s the statements previously used for Production Crop Science and Soils Science options were used for Agronomy, Crop Science and Soils Science majors.

The Plant Pathology Major in Agriculture was offered to students interested in intensive study of plant disease. Courses emphasized recognition, development, and cause of diseases and means to control them. Because bacteria, fungi and viruses were principal biological agents of disease, and disease was an interaction between plants and agents, courses were selected to strengthen this understanding (Cat 1972-3).

The Agronomy Major included one semester each in Crop Production, Biology, Algebra or Algebra-Trigonometry, English Composition, Introduction to Sociology and Soils, one or two semesters of General Chemistry, two semesters of Physical Fitness and 4 to 8 hours of electives for a total of 32 semester hours.

Sophomore courses included one semester each of Weed Control, Biology, Principles of Plant Pathology, Principles of Economics, Fundamentals of Speech, Elementary Organic Chemistry, General Microbiology, Crop and Livestock Insects and six hours of electives for a total of 32 semester hours.

Juniors were required to take Forage Crops and Pasture Management, Conservation and Management of Soils, Soil Fertility and Fertilizers, Seed and Grain Technology or Grain and Seed Production and Processing, Geology, Genetics, Animal Nutrition, Junior English Composition and five hours of electives for a total of 32 semester hours.

Seniors took Undergraduate Seminar, Plant Physiology, Statistical Methods I, Advanced Exposition (English), American or State Local Government, electives in Humanities and Sociology and nine hours of unrestricted electives for a total of 32 credit-hours (Cat 1978-80).

The Crop Science Major included many of the same courses some of which were taken during a different year. However, there were several differences. The 5-hour course in Algebra-Trigonometry, Statistical Methods, Mathematical Analysis I and II, Computer Programming and Plant Breeding were required instead of Conservation and Management of Soils, Soil Fertility and Fertilizers, Geology and Weed Control. The Crop Science Major included only 10 hours of unrestricted electives (Cat 1978-80).

The curriculum for the Soil Science Major differed from the Agronomy Major in that it included the 5-hour course of Algebra-Trigonometry, Elementary Physics I and II, Mathematical Analysis I, Quantitative Analysis, Soil Geography and Land Use, Physical Climatology and Meteorology and Physical Environment of Soils and Plants instead of Introduction to Sociology, Crop and Livestock Insects, Forage Crops and Pasture Management, Seed and Grain Technology, Genetics, Animal Nutrition, Physics 101, Plant Physiology and Statistical Methods I. The Soil Science Major also allowed only 10 hours of unrestricted electives (Cat 1978-80).

The Plant Pathology Major for Agriculture differed from the Agronomy Major in that it included Plant Kingdom, Mycology, Principles of Plant Pathology I, 12 hours of Plant Science electives and two courses in Algebra instead of Forage Crops, Conservation and Management, Seed and Grain, Geology and Animal Nutrition (Cat 1978-80).

The Entomology Major in 1979 was offered to students interested in the study of insects as a basic course or with the application to insect control and management procedures. Courses were designed to explore the fundamentals of entomology and to develop control or management procedures which integrated biological or chemical methods (Cat 1980-2).

The Pest Management Major was designed for the student who would be employed in several facets of agriculture including the agricultural chemistry industry; pest management consulting firms; state and federal administrative, regulatory and extension positions; and farming and ranching operations following graduation. The student would have breadth in the areas of pests and pest management, crop and/or livestock production and a strong base in allied sciences, communications and social science courses (Cat 1980-2).

SURVEY OF PLANT SCIENCE ALUMNI B. L. Brage

The main purpose of a survey of this nature is to gain information that will be of assistance and value to the staff in the Plant Science Department as they plan their strategy for the future. It will also be of value to the students at South Dakota State University as they look for meaningful as well as enjoyable careers. If present alumni are successful and satisfied in their positions in life, that tells quite a story to our present students.

Those alumni with majors previously and now administered by the Plant Science Department at South Dakota State University were sent

survey forms. The addresses used were those on file at our Alumni Office. Out of 412 alumni on file, 315 or approximately 76% responded which is a very good response in a survey of this nature. The majors involved were Agronomy, Crop Science, Entomology, Pest management, Plant Pathology, Plant Science (a previous designation) and Soil Science. Of those responding, only eight were women. Only recently have many women started to major in the above fields. On the other hand, it was interesting to note that the person holding the earliest degree granting date (1932) was a woman.



B.L. Brage, long-time soils instructor and Director of Resident Instruction in Agriculture, advising students.

Residence Of Alumni

Data from the survey indicate that 139 of those responding to the question on residence are living in South Dakota at the present time. That figure is equivalent to 47.8% of the total number. Twenty-eight are living in Minnesota, 20 in Iowa, 15 in Nebraska, nine in California, eight each in North Dakota and Texas, five in the state of Washington, four each in Colorado, Illinois, Indiana, Michigan and Wisconsin, and three each in Kansas, Montana, Ohio, Oregon, Tennessee and Virginia. In total, including those states with one or two individuals each, Plant Science alumni are residing in 32 different states and one foreign country.

Undergraduate Major

There have been changes in name for majors administered by the Plant Science Department since its establishment. The primary ones over that period of time are tabulated in Table 1.

Table 1. Undergraduate major of alumni.

Major	Alumni	
	No.	%
Agronomy	181	57.3
Crop Science	7	2.6
Entomology	25	7.9
Plant Pathology	14	4.4
Plant Science	17	5.4
Soil Science	43	13.6
Other	26	8.2
No Response	2	.6
TOTAL	315	100.0

The majority (181) of the students in this survey had Soil Science for a major, and 25 majored in Entomology. The other majors included 7 in Crop Science, 14 in Plant Pathology and 17 in Plant Science (a designation in the 1960s). Finally, there was quite a sizable group (26) that indicated Other for an undergraduate major. These people, for the most part, were graduate students who either majored in some field at South Dakota State University or from some other institution also with a different major than those listed. Such majors included four in Environmental Management or a similar program, two in Genetics, three in Biology, three in Botany, two in Animal Science, two in General Agriculture, and one each from a number of other fields.

Employment Status

In 1980, 218 or 69.3% of the Plant Science alumni were salaried individuals (Table 2).

Table 2. Employment status of alumni.

Status	Alumni	
	No.	%
Salaried	218	69.3
Business Partner	13	4.1
Self-Employed	65	20.6
Student	6	1.9
Other	12	3.8
No Response	1	.3
TOTAL	315	100.0

Those in the second largest group, 20.6%, were self-employed individuals. A great majority of this group were farmers and ranchers, but a number also operated their own business other than farming or ranching. A few were in professional practices such as medicine. Six were graduate students. Of those that checked "Other," six were retired and two were home-makers.

Type of Employment

Seventy-two or 22.9% of the Plant Science alumni stated that they were actively farming or ranching for their livelihood (Table 3).

Table 3. Relation of employment to agriculture.

Type of Employment	Alumni	
	No.	%
Farming or Ranching	72	22.9
Agriculture Related	193	61.3
Non-Agriculture	42	13.3
No Response	8	2.5
TOTAL	315	100.0

Another 61.3% were employed in agriculturally related positions leaving 15.8% in jobs not related to agriculture or that did not respond to the questions. Such overall data suggest that job opportunities are truly available in the broad field of agriculture.

In the preceding paragraph and also in Table 3, the alumni in broad terms described the relation of their occupations to agriculture. In Table 4, the types of employment are indicated more specifically.

Table 4. Employment types for Plant Science alumni.

Type of Employment	Alumni	
	No.	%
Farming or Ranching	69	21.9
Farm Supplies (feed, seed, ag Chemicals, etc.)	63	20.0
Services (for organizations insur., vet.)	9	2.9
Food Mfg. and Distr.	10	3.2
Management (bank, prof., farm mgt., etc.)	12	3.8
Education (elem. sec.)	2	.6
Higher Education (coll./univ.)	46	14.6
Government (fed., state, city)	64	20.3
Other	29	9.2
No Response	11	3.5
TOTAL	315	100.0

Farming and Ranching takes the lead with 21.9% of the total. There is a slight discrepancy in that figure as it is compared to a similar figure in Table 3. That very likely can be explained by a somewhat different interpretation by a few relative to the two questions. Those involved with farm supplies and those in Government services ranked very close to Farming and Ranching. The above three areas accommodated essentially two-thirds of all Plant Science alumni. A fairly sizeable group (14.6%) are employed by some college or university. This group evolved primarily from the graduate program within the Plant Science Department.

The remainder of the alumni were spread out through the Services (2.9%), Food manufacturing (3.0%), Management (3.8%) and Primary as well as Secondary Education (.6).

A very sizeable number (9.2%) did not believe their position fit any of the above categories. Of this group, 2 were medical doctors, one a druggist, one a pilot, and five were in the armed forces and several were either in the insurance, banking or real estate business.

Closeness of Job to Major

It is always interesting to learn how closely the career of an alumnus relate to the major followed by him/her in college.

Table 5. Relationship of major to present position.

Relationship	Alumni	
	No.	%
Closely	188	59.6
Somewhat	86	27.3
Not Related	37	11.8
No Response	4	1.3
TOTAL	315	100.0

Of the Plant Science alumni, 86.9% stated that they were working in an area either closely (59.6%) or somewhat (27.3%) related to the major they followed while in college. This is an unusually high figure, which probably points to the strong opportunities in the Plant Science fields.

Year of Graduation

Data in Table 6 indicate the year in which the alumnus earned his/her final degree, whether it be a B.S., M.S., Ph.D. or other degree.

Table 6. Year in which highest degree of alumnus was earned.

Years	Alumni	
	No.	%
1931-35	1	.3
1936-40	2	.6
1941-45	1	.3
1946-50	5	1.6
1951-55	11	3.5
1956-60	39	12.5
1961-65	42	13.3
1966-70	34	10.8
1971-75	88	28.0
1976-80	68	21.3
No Response	25	7.9
TOTAL	315	100.0

Essentially one-half (49.3%) earned their final degree since 1970. Only 6.3% earned their degree prior to 1955. It is possible that the earlier alumni have not kept in good contact with our alumni office since graduation and therefore, we were not able to communicate with some of them.

Highest Degree Earned

One hundred ninety-seven (62.6%) terminated their college work with a B.S. degree from SDSU (Table 7).

Table 7. Highest degree earned by alumni.

Degree	Alumni	
	No.	%
B.S.	197	62.6
M.S., M.A., Ed. M., M.F.	57	18.1
M.B.A.	2	.6
Ph.D., Ed.D.	53	16.8
M.D., D.D.S.	2	.6
Other	3	1.0
No Response	1	.3
TOTAL	315	100.0

A fairly sizeable group proceeded on to a higher degree--18.1% for the Master's degree, and 16.8% for either the Ph.D. or Ed.D. degrees. Two went on for a degree in medicine and two others for a M.B.A. degree.

Salary Information

The beginning salaries for each alumnus are summarized in Table 8 while their present salaries are reviewed in Table 9.

Table 8. Starting salary on first job.

Salary	Alumni	
	No.	%
Less than 4999	90	28.6
5000-5999	38	12.1
6000-6999	27	8.6
7000-7999	16	5.1
8000-8999	26	8.2
9000-9999	24	7.6
10,000-10,999	27	8.6
11,000-11,999	13	4.1
12,000 or more	34	14.1
No response	19	6.0
TOTAL	315	100.0

Table 9. Present salary of alumni.

Salary	Alumni	
	No.	%
Less than 9999	18	5.7
10,000-13,999	29	9.2
14,000-17,999	30	9.5
18,000-21,999	56	17.8
22,000-25,999	46	14.6

26,000-29,999	27	8.6
30,000-33,999	27	8.6
34,000-37,999	14	4.4
38,000 or more	40	12.7
No Response	28	8.9
TOTAL	315	100.0

The effect of inflation is very noticeable as a review of Table 8 is made. For the earlier alumni, a salary of \$5,000 on the first job was near the "top of the rung." Today such a salary is a very meager one. Data in the first table are complicated by the fact that in some cases the first job follows an advanced degree such as a Ph.D. while others follow the B.S. The data indicate that roughly 50% of the alumni started on their first job with a salary of \$7,000 or less. In comparing those figures to data in Table 6, the \$7,000 salary figure would relate generally to alumni who received their final degree prior to 1970. Those receiving less than \$5,000 on their first job very likely received their degree prior to 1965.

Table 9 indicates that there is considerable spread in present salaries for Plant Science alumni. This could be expected for the data include all people from the student with very little salary to a person at his/her peak salary and finally to the retired individual.

The data indicate that roughly one-half of the alumni are earning a salary of \$22,000 or more when the survey was made and thus a similar number were earning less than that amount. Close to 13% of the alumni were earning \$38,000 or more. That figure could also be still higher for the 8.9% that did not respond to the question concerning their present salary.

The most common salary for those farming and ranching was in the \$14,000 to \$18,000 range and in over the \$38,000 area. Those dealing in farm supplies were earning salaries generally in the \$14,000 to \$26,000 range. Higher education and the government agencies were providing a median range in salary from \$18,000 to \$26,000. For all other occupations the salaries were fairly well scattered across the entire scale.

Of those 40 people earning \$38,000 or more, 11 are farmers or ranchers, 9 in sales, 6 in government positions, primarily federal, 4 at colleges or universities, 5 in research, development and technical service, 2 are medical doctors and 1 is a pilot. The remainder have different responsibilities in the financial field.

On the "other side of the coin" for those earning \$10,000 or less, 10 are farmers or ranchers. Very likely many of these are "just getting started", probably right out of college. Six are graduate students; one indicated that he is in the army and the other is a homemaker.

Further Course Work

If an academic program on campus is to be a

strong and meaningful one, it must be alive and ever-changing with the times. One very good way of learning how to improve a curriculum is to ask the graduate for his/her suggestions as to how a program might be changed.

In Table 10 are indicated from Plant Science alumni as to what course work they would have liked to have taken in addition to the program that they did follow while at SDSU.

Table 10. Need for further coursework as indicated by alumni.

Course Area	Course							
	No.	%	No.	%	No.	%	No.	%
Agronomy and Other Ag Related	88	28.0	41	13.0	25	7.9	154	16.3
Basic Science and Math	36	11.4	31	9.8	27	8.6	94	9.9
Business	85	27.0	69	21.9	27	8.6	181	19.2
Communications	17	5.4	49	15.5	48	15.3	114	12.1
Computer Science	18	5.7	28	8.9	48	15.3	94	9.9
Humanities	3	.9	5	1.6	13	4.1	21	2.2
Social Sciences	2	.6	5	1.6	12	3.8	19	2.0
Other	17	5.4	9	2.9	10	3.2	36	3.8
No Response	49	15.6	78	24.8	105	33.2	232	24.6
TOTAL	315	100.0	315	100.0	315	100.0	945	100.0

The number one choice for additional courses was the addition of more agronomy and other agriculture related courses. The desire for more business followed a close second. When all three choices were added together, business gained the largest number of votes while the agronomy and ag related group came in second. The need for further courses in communications was especially strong at the second and third choice level. This was also true for Computer Science. Science and mathematics was the first choice for by 11.4% of the alumni, ranking third behind agronomy and business.

The desire for further Humanities and Social Science courses was not very evident. This could partially be explained by the fact that generally the group surveyed is a relatively young group--roughly 50% having received their final degree since 1970 and 75% since 1960. Other surveys have shown that recent graduates are very concerned about the immediate demands of their profession and thus are concerned about science, mathematics, agriculture, business, communications and so forth, while people who have been "out in the field" for a longer time become interested in some of the so-called "good things in life" and thus appreciate the need for more humanities and the social sciences.

Summary

1. The median beginning salary during the period 1931 to 1980 was \$8,000, a salary which was essentially \$4,000 less than that received by a beginning undergraduate in 1979. The median salary in 1980 for all Plant Science alumni was \$24,000.

2. One hundred thirty-nine or 47.8% of Plant Science alumni are living in South Dakota.; 28% reside in Minnesota while 20 live in Iowa.

3. Of all Plant Science alumni, 218 or 69.3% are salaried; and 65 are primarily self-employed.

4. Seventy-two or 22.9% of the alumni are farming or ranching. One hundred ninety-three or 61.3% are in ag related positions other than farming and ranching.

5. Two hundred seventy-four (86.9%) of the alumni stated that the nature of their present position is close or fairly close to the major that they followed in college, quite a tribute to the supply of jobs available to a major in the general field of Plant Science.

6. Further business, agronomy and other agriculture related courses were most often listed by alumni as needed additions to a major in the Plant Science field.

DEPARTMENT GRADUATES

In the early years all agricultural students were in essentially one program. Later on there were departmental designations but names were not separated by department in the graduation program until 1947. The following table shows the number of students enrolled in plant science courses (agronomy, plant pathology and entomology) for the last decade and a half as well as the number of the B.S., M.S. and Ph.D. graduates since 1947 (Brage).

Year	Number enrolled in Plant Science courses	Number of graduates with following degrees		
		B.S.	M.S.	Ph.D.
1947			1	
1948			5	
1949			1	
1950			1	
1951			2	
1952			2	
1953		6	1	
1954		11	5	
1955		10	2	
1956		12	6	
1957		12	9	
1958		20	7	
1959		33	6	1
1960		18	7	
1961		12	4	3
1962		10	4	5
1963		18	6	3
1964	1050	12	5	4
1965	1166	7	6	
1966	1212	12	2	2
1967	1227	18	7	1
1968	1224	5	6	1
1969	1369	11	5	1
1970	1288	15	3	
1971	1465	4	8	4
1972	1602	19	9	3
1973	1386	18	5	5
1974	1480	17	5	5
1975	1550	17	5	3
1976	1576	19	9	1
1977	1507	9	9	1
1978	1365	23	4	2
1979	1251	18	7	1
TOTAL	--	--	--	--

When attempting to develop a list of Agronomy graduates it was learned that a complete list does not exist. The SDSU Alumni Association provided an extensive list, but it was

found to be incomplete. Therefore, that list was supplemented by various other lists.

Master of Science Graduates

Most recipients of graduate degrees were listed in earlier chapters, however, there were a few early degrees not recorded--John M. Aldrich 1891, Cyril G. Hopkins 1895, Ellery C. Chilcott 1898, Oscar R. Mathews 1909, Howard Loomis 1916, Harry Rilling 1916 and Glen Hoon 1920. Lists of faculty indicate that Manley Champlin obtained an M.S. degree in 1914, but his name was not included on lists of M.S. graduates.

Aldrich, an entomologist received the first M.S. degree conferred by SDAC. Hopkins was Acting Professor of Pharmacy at SDAC in 1893, but went to the University of Illinois where he became a prominent soils man and Assistant Director of Experiment Station. He developed an acronym from his name "C. Hopkins Cafe Mighty good" using the letters C HOPKNS CaFe Mg which were the chemical symbols for the 10 elements that were known, at that time, to be essential for plant growth. This acronym was used in soils classes for many years to teach students how to remember the 10 essential elements.

Chilcott was the only member of the Geology and Agronomy Department and senior member of the Geology, Agronomy and Agricultural Physics Department at SDSC as well as being Vice Director of Experiment Station. Mathews was Agronomist at the Belle Fourche Field Station for several years, while Loomis, Rilling and Hoon were members of the Agronomy Department at SDSC.

Agriculture Graduates

Prior to 1931 agricultural students majored in Agriculture, though they had been allowed to specialize in Agronomy and other fields for over 20 years. College catalogs listed all alumni until 1922, and names of people that were known to have chosen a profession in crops (C) or soils (S) are listed here. The alumni list covered the years 1912 to 1931. Names of people on that list, though they may have specialized in agricultural education, that spent many years working in the field of agronomy are included. Several of them were on the staff of the Agronomy Department (A). Johnston (1916) served as Extension Agronomist for 18 years and Ladd was Extension Conservationist for over 10 years. Ross Davies was the first State Soil Conservationist and several others were active in the SCS for many years. Three farmers were long time members of the Crop Improvement Association (CIA) that was so helpful in securing funds for research on crops and soils. Charles Gilbert was a long time State Weed Supervisor.

90 S	Hopkins Cyril G.	18 C	Gilbert Charles J.
96 C	Carter Lewis C.	20	Bucholz Rudolph
96 S	Holm Andrew B.	20	Ladd Leonard L.
03 C	Cole John S.	22 SE	Overseth Oliver
04 CIA	Sanderson Everett	23 SCS	Avery Glenn
07 C	Dillman Arthur C.	23 SCS	Davies Ross O.

07 C	Salmon S. Cecil	24 CA	Franzke Clifford J.
08	Mathews Oscar R.	25 SA	Puhr Leo F.
10 A	Biggar Howad H.	26	Soule William K.
12 CA	Oakland Irwin S.	26	Hume Albert
13 CA	Fowlds Mathew	26 SCS	Mateer H. A.
13 CIA	McHugh Frank J.	27	Ulvin Gus B.

13 SA	Rilling Harry M.	27 SCS	Cobb Lloyd O.
14 SA	Bushey Alfred L.	28 SCS	Daniels Edward J.
16 CE	Johnston Ralph E.	30	Parmeter Walter W.
16 S	Warner Harry	30	Baun Philip J.
17 A	Winwright George	30 SCS	Haisch Lloyd
18 SA	Hoon Glen	30	Sander Albert F.
18 C	McFadden Edgar S.	31 CIA	Rardin Wesley F.

Pathology Graduates

A partial list of Plant Pathology graduates appears on page 35. It is included here with names of students obtained from the alumni list prior to 1970. Some of the students were in agriculture and some in Arts and Sciences.

58 Hauch James N.	60 Lowell Roger L.
60 Heifner Dennis R.	60 Pratt Adrian

61 Nelson Gordon A.	68 Watson Orlando S.
65 Smolik James D.	69 Borondeau Bruce L.
61 Kruse Kenneth C.	

Agronomy Graduates

The Agronomy Department conferred B.S. degrees for 39 years. Students majored in either Field Crops and Soils during the 1930s and in Agronomy for over a quarter century. Agronomy majors, however, were allowed to choose options in crops, soils or production much of the time.

Because of the depression, enrollment was low during the 1930s but it was even lower during the World War II years. There were only eight students enrolled in the Division of Agriculture in 1943-4. There were only three graduates in 1944-5 and 16 the next year. The number increased to 49 in 1946-7 and there were strong increases after that (Brage).

The names on the following list were obtained from three lists--an alumni list of agronomy graduates, an alumni list of agriculture graduates for the years 1931-1947 and a list prepared by R. C. Kinch. Names from the latter two lists included some who may have had a double major and appear on the Alumni Association list for the other department. Their areas of specialty are indicated for crops (C) or soils (S).

31 Rietz Glenn A.	41 Nold Maurice M.	49 S Johnson Esbern V.	52 C Geise Harry A.
31 Steele Harry A.	41 S Rebsch Donald L.	49 S Kettering Dwayne I.	52 C Hurlbert Harold T.
34 Weeks Martin E.	41 C Sandal P. Conrad	49 C Mehl John C.	52 Larson Eugene C.
35 Hermann Wilford W.	41 S Ulrich Rodger	49 S Moldenhauer William	52 Lawrensen Burton E.
35 Leary William J.	41 C Wells Darrell G.	49 C Mueller Eldor P.	52 C Lunden Allyn O.
35 Svanoe Sigvard C.		49 C Sperry George C.	52 C Nelson Leonard O.
	42 C Banek Berthold J.		52 C Thomas Jordan B.
36 Bankert Rex N.	42 Barber Myron	50 S Boehmer Edward A.	52 C Torve Kermit S.
36 Davidson Bjorn	42 Fineran Roland J.	50 S Feind Charles E.	52 Walz Arnold
36 S Olson Oscar E.	42 Fox H. Raymond	50 C Harpstead Dale D.	52 C Weidenfeller Theodore A.
37 Evans T. Allen	42 Hamilton R. Wayne	50 C Holtry J. E.	
37 Fenner Victor A.	42 Julin Glen B.	50 C Johnson Donald D.	53 S Bender Harvey S.
37 Joy Edgar	42 Kelsey Clayton B.	50 C Johnson Sidney A.	53 C Engel Freddy
37 Simonson Conrad R.	42 Krell Edward E.	50 S Kettering Dwight E.	53 C Gunderson Wallace
37 C Zuber Marcus	42 Nestrud Lorne M.	50 C Lippert Herbert A.	53 S Mortvedt John
	42 Rinnan Harold	50 C Miller Neil	53 C Schornack Allen
39 S Arms Ralph	42 C Sanderson Elmer E.	50 C Nachtigal Glen E.	
39 Brandriet Raphael L.	42 Schroeder George F.	50 S Norgaard Daniel A.	54 C Abeln Alvin
39 Dobberstein Ervin	42 C Taylor Lincoln H.	50 C Pringle Wade R.	54 C Bau Vernon
39 Flittie David	42 S Wiersma Daniel	50 C Ryther Carl	54 S Boyer Delayne
39 Forbes James L.		50 S Schloter Thomas	54 C Budahl Elton J.
39 Jorlin Francis M.	43 C Derscheid Lyle A.	50 S Wennblom John A.	54 C Foster A. Earl
39 Joy Louis E.	43 Wiley Francis K.	50 C Wermers Robert J.	54 S Harpstead Milo
39 Kaiser Leo M.	47 Howe Laurel L.	50 C Bentz Laurence	54 C Hoffbeck L. John
39 Keck C. Wayne	47 Kenzy John E.		54 S Kurpjuet Fred J.
39 Keller Kenneth	47 Redlin Earl H.	51 S Bierwagen Gilbert	54 C Laboree Lyle
39 Nelson Klayton E.	47 Sagness Milford L.	51 C Bonnemann Joseph J.	54 S Martin George
39 Olseth Olaf H.	47 Schooler Arnold B.	51 S Chamberlain Earl	54 C Nash Russel L.
39 Ptak Lloyd J.	47 C Thompson Donald L.	51 C Collins John W.	54 C Nordquist Paul T.
39 Thompson J. R.	47 Vader Robert	51 S Dodge Rodney	
39 Vandall Arthur B.	47 S Williamson Edward J.	51 Duerre Lloyd P.	55 S Baxter Paul
		51 C Dunlap Wesley D.	55 S Bonestell Robert
40 S Frederickson Charles D.	48 C Anderson James U.	51 C Jensen Stanley D.	55 S Carlson Robert
40 C Hicks Glenn T.	48 C Erion Gerhardt W.	51 C Klint Curtis P.	55 C Johnson Delmer
40 Kettering Allen D.	48 Glover William R.	51 S Krueger John H.	55 C Meinhardt Robert
40 Masson Roy N.	48 Keehn Gerald L.	51 S Lamke Wayne E.	55 C Moriarty Pat
40 Wik Harold T.	48 C Kratochvil Donald E.	51 C Newell Raymond J.	55 S Raver Miles
40 Wilson Woodrow	48 C Taylor Roscoe L.	51 C Peterson Marvin S.	55 S Zick Walter
	48 C Wilcox Keith	51 S Switzer Merle E.	
41 S Jornlin Donald F.			56 C Bue Harvey K.
41 Moran William J.	49 Balo Eric R.	52 S De Kramer Dale L.	56 C Daum Samuel J.
41 Mueller Arndt L.	49 S Buntley George J.	52 C Ellis Donald A.	56 C Fletcher Wayne
41 C Neuschwander John A.	49 Fuller James E.	52 S Fox Lorenz M.	56 C Hanson George P.

56 C Haensel Hubert	59 C Cech Dale G.	61 C Bierman Robert H.	64 C Schiernbeck Robert
56 C Kingsley Quentin S.	59 S Delaney Gary J.	61 CS Eide Terrance	
56 Komanetsky Michael	59 C Erichsen Alvin W.	61 S Glatt Francis P.	65 S Diebert Edward J.
56 C Krier Merl R.	59 C Griep Clarence W.	61 C McCarty Charles A.	65 C Halverson Phillips
56 C Nelson Rupert R.	59 C Hanson Jerry A.	61 C Schaeffer Victor	65 S Heil Kenneth J.
56 S Nesby Wayne	59 C Hoffbeck Robert L.	61 C Sckerl Max M.	65 C Palm Harlan
56 S Parmeter Adrian	59 C Jacobsen Kenneth L.	61 S Velde Ole T.	65 C Seefeldt Merritt A.
56 C Termunde Darold E.	59 C Jorgensen Merlin L.		
56 S Wilding Lawrence P.	59 C Kelly Thomas A.	62 C Boeder Verlin G.	66 Berlyn Bryan
	59 S Kluckman Duane	62 C Bray Richard E.	66 Dovre Allan E.
57 C Culhane Chas D.	59 S Kobriger Laurence L.	62 C Duerr Donald H.	66 Gustafson James E.
57 S Davis Lloyd	59 C Kompelien David T.	62 C Fish Robert C.	66 Johnson Paul
57 S Kunze Lawrence D.	59 S Koopman Vernon F.	62 S Krebs Larry G.	66 Lopez Eluid
57 S Meland Arvid C.	59 S Kruse William D.	62 C Labahn Leslie L.	66 Newlin Harris E.
57 C Noeldner Orville	59 S Larson Kermit N.	62 C Rath Raymond W.	66 Peterson Norris L.
57 S Papendick Robert	59 C McMurray Kenneth E.	62 C Richter Allen R.	66 Rau Rodney
57 C Roth Albert H.	59 S Mielke Walter K.		66 Roebke Michael S.
57 C Schrader Duane R.	59 S Miller Kenneth F.	63 C Bormann Joseph J.	66 C Stymiest Clair E.
57 S Stensland Ralph	59 S Paulsen Norman J.	63 C Frank Ronald J.	
57 S Stoner Clinton D.	59 C Rosenthal Robert L.	63 S Heil Dennis M.	67 Baum Randy O.
57 C Wright Wayne G.	59 S Schultz Loren D.	63 C Heitman Garry R.	67 C Birir John O.
	59 S Severson Larem	63 C Klosterboer Arlen D.	67 Briscoe John H.
58 C Brandsma Loren	59 C Stroup Fred E.	63 C Larsen Donald R.	67 Kelly William J.
58 C Brose Vernon A.	59 S Swenson Robert L.	63 S Larson Donald K.	67 Koth Douglas D.
58 C Hedman Robert E.	59 C Wedstrom Neil	63 C Melius Dale A.	67 Lounsbery Richard C.
58 C Holm Elmer	59 C Wiesner Floyd S.	63 C Schacht Larry G.	67 Masteller Vance J.
58 S Kavar Faisal T.	59 S Williams Theodore B.	63 C Stone John D.	67 Njeru Jotham
58 S Kunze Gordon		63 C Tarrell Ronne D.	67 Okelo Walter W.
58 C Larson Paul L.	60 S Bezdicek David F.	63 C Twitero Charles L.	67 Street William L.
58 C Likness James C.	60 C Brisbin Harold G.	63 S Weber James B.	67 Thaden Ronald T.
58 C Lienemann John E.	60 CS Gilman Ronald D.	63 C Wicks Jerry D.	67 Wagner Howard P.
58 S Mach Jerry L.	60 S Heil Robert D.	63 C Wiedmeier John E.	67 Wegerd George P.
58 C Metz Wilfred J.	60 C Heppler Kenneth D.	63 C Wiitala Dale W.	
58 C Meyer Marvin A.	60 C Hofer Wesley R.	63 C Wullweber Dwight A.	68 C Johnke Leroy E.
58 S Paschke Lyle D.	60 C Holean Gary		68 C Kominek James E.
58 C Peters John	60 S Mitchell Robert F.	64 C Amendt Richard W.	68 Kost Merle M.
58 C Sawinsky William J.	60 S Monson John E.	64 C Briscoe James H.	68 Mausbach Maurice J.
58 C Slupe LeRoy	60 C Petersen Stanley M.	64 C Bunde Merlin E.	68 Watson Orlando
58 C Staininger Raymond B.	60 C Rabenberg James R.	64 C Decker Robert I.	
58 C Stone Russell L.	60 Rehder Merlyn	64 C Escutia Hector, Jr.	69 Baatz Edwin W.
	60 S Rezek Lawrence D.	64 C Escutia Sergio	69 C Biggar Charles C.
59 S Aamold Larry A.	60 C Tekrony Dennis M.	64 C Flanagan James L.	69 C Coulter Dennis L.
59 C Artz Edwin G.	60 S Zischke Norman E.	64 C Kruse Gary D.	69 C Freiwald Leonard C.
59 C Bray Darold D.		64 C Mohror Robert A.	69 C Grenz Gregory K.
59 C Burns Thomas D.	61 S Aamold David E.	64 S Peters Joseph F.	69 S Pfeifer James H.
59 C Buske Kenneth C. Jr.	61 C Ammann George F.	64 C Sandine Ronald R.	

Plant Science Graduates

The names in this list were obtained from the Alumni lists for Agronomy and Plant Pathology and from the list compiled by Betty Christensen, Administrative Assistant in

Plant Science, from commencement programs. It is believed to be accurate. Their areas of specialization are indicated for Agronomy (A), Crop Science (CS), Soil Science (SS), Plant Science (PS), Plant Pathology (PP) and Entomology (E).

70 PP Bode Fred L.	72 C Butler Roger D.	73 A De Wilde Earl J.	74 CS Finnegan Steven L.
70 SS Carstrom Robert	72 A Floyd William	73 SS Duba Jerry L.	74 A Frey Roger R.
70 CS Deba Raphael	72 S Gelderman Ron H.	73 SS Halbeisen James L.	74 SS Fried James C.
70 CS Deibert Gregory C.	72 C Heida Dalen R.	73 PS Hall Terence L.	74 SS Hageman Neil R.
70 A Eastman Eugene A.	72 A Keal Barry R.	73 PS Hodson Dale L.	74 A Hainy Keith W.
70 SS Goeman Elton S.	72 C Locken Roger W.	73 A Lehman Robert W.	74 SS Heikes Russell
70 CS Herrick Roger D.	72 C Nelson David M.	73 PS Mason Terry A.	74 A Houska Kenneth A.
70 CS Henrichs Wayne B.	72 S Olson Kendall K.	73 PS Patterson Paul D.	74 A Howard Russell W.
70 Jenison John R.	72 CS Osthus Rodney C.	73 PS Poppen Lauren L.	74 A Johnson Craig D.
70 PS La Compte Michael J.	72 C Ringstmeyer Richard R.	73 PS Randall David L.	74 A Kunze Bruce O.
70 CS Leslie Lorin	72 CS Rosdail Jay R.	73 A Reber Nilo G.	74 A Obermoller Ronald
70 CS Ogada Joash	72 PP Safford Joann	73 PP Schwerin Steven L.	74 A Olson Wayne A.
	72 SS Schladweiler John T.	73 A Schultz Quentin E.	74 A Parmely Ronny F.
	72 SS Simons Patrick J.	73 A Spilde Terry A.	74 A Rieckman James A.
71 PP Kettering Steven W.	72 CS Sweetter Gordon W.	73 PS Stadther Richard L.	74 A Tichota Jeffrey M.
71 Mangold George W.	72 A Wagner Robert J.	73 PS Street Steven T.	74 A Zeilstra John T.
71 Reich Leon A.	72 C Werkmeister Wayne R.	73 A Teerink Roger D.	
71 Schumacher Thomas M.	72 SS Williams Max R.	73 A Theodor Christopher	75 A Bergh Garland M.
71 Smith Charles N.		73 PS Vasgaard Richard G.	75 SS Blumhardt Glenn A.
	73 A Auwarter Gordon E.	73 CS Wilson Larry G.	75 A Buchholz Daryl D.
72 C Bainbridge Lewis G.	73 Bartling Frederick J.		75 A Bushfield Mark O.
72 C Beckler Stanley H.	73 A Corson Duane A.	74 A Alverson Ronald C.	75 SS Clausen James A.

75 A Hamernik Lucien C.	76 A Thaden Daniel J.	78 PP Lotz Robert F.	79 A Sanders Michael H.
75 CS Koopman Michael A.	76 A Van Tassel Steven R.	78 A Mulder Richard D.	79 A West Wallace J.
75 A Lichty Lee W.	76 A Washnok Dale E.	78 A Peterson Frank W.	
75 A Magedanz Steve A.	77 A Amundson Ronald G.	78 A Poppens Marilyn J.	80 A Abrahamson Ruth
75 A Nielsen Robert D.	77 EM Anderson Daniel L.	78 A Price Mark F.	80 PP Adrian Stuart K.
75 A Null Jerry L.	77 A Auch Dennis R.	78 A Rankin Robert D.	80 PP Boyett John N.
75 A Quinn Thomas G.	77 A Barber Brian D.	78 A Robbennolt Lewis B.	80 A Branick Kevin T.
75 A Rix Roger L.	77 A Christensen Robin D.	78 A Stiefel Michael J.	80 A Brockmueller G. L.
75 A Roskens Arlen B.	77 A Curry Daniel G.	78 A Vedvei Alan J.	80 A Carlson Carl M.
75 A Schiefelbein Brad	77 A Deutscher David W.	78 A Westergreen Lowell	80 SS Fischer Steven K.
75 A Sogn David A.	77 A Flaten William D.		80 SS Hiller Joseph G.
75 PS Stout Jerome M.	77 A Forkrud Darwin K.	79 PP Ahlers Carol L.	80 A Horsley Duane M.
75 A Tobin Rodney E.	77 A Kehrwald Kevin J.	79 A Allen Frank D.	80 A Huber Delyle L.
75 PP Wendell Daniel L.	77 A Merkwan John A.	79 E Bohls Roger A.	80 SS Little Richard S.
	77 PP Nordquist Terrance	79 A Bowker Edward J.	80 A Lynn Jeffrey S.
76 SS Bachman Wayne J.	77 A Orris Loren L.	79 A Branick Patrick S.	80 Mayer Ruth V.
76 A Brenner Charles B.	77 A Quinn Daniel J.	79 A Carter Edward L.	80 A Morrissey Katherine
76 A Buxcel Gene T.	77 A Rindels Rand A.	79 A Crance Adrian L. Jr.	80 A Novak Alvin J.
76 A Dummer Paul F.	77 A Schultz Bradley D.	79 A Davis Steven L.	80 A Olson Roy J.
76 A Englund Brad L.	77 PP Wirth Charles W.	79 A Dinger Donald B.	80 A Paulsen Sharon K.
76 A Erickson Terry R.	77 Woolery Ray C.	79 SS Edwards Douglas J.	80 A Peterson Mark A.
76 A Gustafson Clair D.	77 Wrucke Mark A.	79 A Erickson Robert C.	80 A Smith Randy L.
76 A Hohn Ludwig C.		79 PP Fischer Patricia M.	80 A Stiegelmeier Jerome
76 A Hora James R.	78 SS Assmus Roger J.	79 A Fischgrabe Dennis L.	80 A Zander Kathleen M.
76 A Kempton Kim D.	78 A Caspers Perry J	79 SS Hinzman Larry D.	
76 A Larson Dennis J.	78 A Daniel Dave K.	79 A Johnson Paul O.	81 A Anderson Monte D.
76 A Marquardt Joseph L.	78 A Greger Kenneth E.	79 Krueger Julie M.	81 A Brandt Paul D.
76 A Moore Gordon J.	78 A Helwig Valerie A.	79 A Le Ford Duane R.	81 A Chicoine Timothy K.
76 PS Pangburn Kenneth M.	78 A Jerman Mark S.	79 PP Lehecka John W.	81 A Cronin Monty A.
76 PP Schultz Timothy R.	78 Just Valerie A.	79 A Loehrer Bert J.	81 A Nordquist Timothy
76 PP Schwalm Jerry L.	78 PP Kirby Seth G. M.	79 A Neugebauer Julie M.	1 PP Nylen Steven P.
76 PP Smoot John W.	78 PP Klein Milton J.	79 PP Propst Ralph A.	81 A Priebe Jeff P.

CHAPTER XXXIX PUBLICATIONS

This chapter includes the names of 265 Experiment Station publications, 145 departmental pamphlets, 232 Extension Publications and more than 100 Scientific publications each from Agronomy and Plant Pathology.

EXPERIMENT STATION PUBLICATIONS

Five types of publications were used by the Experiment Station

Bulletins

The first bulletins were more or less a discussion about a particular topic. They then became reports of research work. Some were very comprehensive. Agronomic topics and on plant diseases were discussed in 40 of the first 100 bulletins, 45 in the next 100, 24 that bore the numbers 201-300, 14 with a 300 number, 17 with a number in the 400's, 24 in the 500's and 14 of the next 65 for a total of 164 bulletins of 665 bulletins published by the Experiment Station.

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| <p>B 1, Notes on the Growth of Trees in the College Grounds. 1887. Charles A. Keffer</p> <p>B 9, Corn. 1889.
Luther Foster, Superintendent</p> <p>B11, Small Grain. 1889.
Luther Foster, Superintendent</p> <p>B17, Small Grain. 1890. Luther Foster,
Superintendent of Agricultural Experiments</p> <p>B21, Small Grain. 1891.
Luther Foster, Agriculturalist, MSA Director</p> <p>B24, Corn. 1891.
Luther Foster, Agriculturalist, MSA Director</p> <p>B27, The Sugar Beet. 1891.
James H. Shepard, Chemist</p> <p>B28, Irrigation. 1891. Luther Foster, Director,
& Charles A. Duncan, Irrigator</p> <p>B29, Notes on Parasitic Fungi Observed in
Brookings during the Summer of 1891.
1891. T. A. Williams</p> <p>B33, Some plants injurious to stock. 1893.
T. A. Williams</p> <p>B34, The Sugar Beet. 1893.
James H. Shepard, Chemist</p> <p>B35, Common Fungus and Insect Foes of Farm and
Garden. 1893. T. A. Williams</p> <p>B38, Feeding Wheat to Hogs. 1894.
E. C. Chilcott, Agriculturalist</p> <p>B45, Forage Plants. 1895. Thomas A. Williams,
Botanist and Bacteriologist</p> <p>B48, Potato Scab. 1896.
T. A. Williams</p> <p>B51, Forage Plants for South Dakota. 1897.
E. C. Chilcott, Agriculturalist</p> <p>B52, Irrigation in South Dakota. 1897.
James H. Shepard, Chemist and E. C.
Chilcott, Agriculturalist</p> <p>B54, Subsoiling. 1897.
N. E. Hansen, Horticulturalist</p> <p>B56, Sugar Beets in South Dakota. 1897.
James H. Shepard, Chemist</p> <p>B59, Forage and Garden Crops in the James River
Valley. 1898. James H. Shepard, Chemist
and E. C. Chilcott, Agriculturalist</p> <p>B60, Millet. 1898. E. C. Chilcott,
Agriculturalist and D. A. Saunders, Botanist
& Entomologist</p> | <p>B61, Forage and Garden Crops in the James River
Valley. 1899. E. C. Chilcott,
Agriculturalist and R. S. Roe, Farm
Superintendent</p> <p>B62, Sugar Beets in South Dakota. 1899.
James H. Shepard, Chemist and W. H. Knox,
Assistant Chemist</p> <p>B66, Drouth-Resisting Forage Plants. Highmore.
1900. James H. Shepard, Chemist, Director
of Exp. Sta.</p> <p>B69, Native and Introduced Forage Plants. 1901.
James H. Shepard, Chemist, D. A. Saunders,
Botanist & Entomologist & W. H. Knox,
Assistant Chemist</p> <p>B70, Drouth-resistant Forage Experiments at
Highmore. 1901. D. A. Saunders, Botanist &
Entomologist</p> <p>B71, Speltz vs. Barley--A Comparison for
Fattening Sheep. 1901. E. C. Chilcott,
Agriculturalist and W. T. Thornber, Herdsman</p> <p>B74, Drouth-resistant Forage Experiments at
Highmore. 1902. D. A. Saunders, Botanist</p> <p>B75, Treatment of Smut and Rusts. 1902.
D. A. Saunders, Botanist and Entomologist</p> <p>B79, Crop Rotation for South Dakota. 1903.
E. C. Chilcott, Agriculturalist</p> <p>B81, Pasture and Forage Plants for South Dakota
(I) 1903. E. C. Chilcott, Agriculturalist</p> <p>B81, Elements of Prairie Horticulture (VI) 1903.
N. E. Hansen, Horticulturalist</p> <p>B82, Macaroni Wheat . . . Its Milling and
Chemical Characteristics. 1903. James H.
Shepard, Chemist</p> <p>B84, Report of Investigations at the Highmore
Station for 1903. 1904. W. A. Wheeler,
Botanist and Entomologist</p> <p>B92, Macaroni Wheat . . . Its Milling and Chemical
Characteristics. 1905. James H. Shepard,
Chemist</p> <p>B94, Alfalfa and Red Clover. 1906. James W.
Wilson, Agriculturalist and H. G. Skinner,
Animal Husbandry</p> <p>B96, Forage Plants and Cereals at Highmore
Substation, 1904-05. 1906. W. A. Wheeler,
Botanist and Entomologist and Sylvester Balz</p> <p>B97, Speltz and Millet for the Production of Baby
Beef. 1906. James W. Wilson,
Agriculturalist and H. G. Skinner, Animal
Husbandry</p> <p>B100, The Value of Speltz for the Production of
Beef and Pork. 1907. James W. Wilson,
Agriculturalist and H. G. Skinner, Animal
Husbandry</p> <p>B101, Forage Plants at Highmore 1906-07. 1907.
W. A. Wheeler, Botanist and Entomologist and
Sylvester Balz</p> <p>B106, Sugar Beets in South Dakota. 1908. James
H. Shepard, Chemist</p> <p>B109, Rusts of Cereals and Other Plants. 1908.
E. W. Olive, Botanist</p> <p>B112, The Killing of Mustard and Other Noxious
Weeds in Grain Fields by the Use of Iron
Sulphate. 1909. E. W. Olive, Botanist</p> <p>B113, Progress in Variety Tests of Barley. 1909.
Clifford Willis, Chief in Agronomy and J. V.
Bopp, Assistant in Agronomy</p> <p>B115, Report of Work for 1907 and 1908 at
Highmore. 1909. Clifford Willis, Chief in
Agronomy</p> <p>B117, Sugar Beets in South Dakota. 1909.
James H. Shepard, Chemist</p> |
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- B11B, Corn. 1910. Clifford Willis, Chief in Agronomy and H. B. Potter, Asst. in Agronomy
- B120, Progress in Variety Test of Alfalfa. 1910. Clifford Willis, Chief in Agronomy and J. V. Bopp, Asst. in Agronomy
- B121, Sugar Beets in South Dakota. 1910. James H. Shepard, Chemist
- B126, Alkali Soils. 1911. Clifford Willis, Agronomy and J. V. Bopp, Asst. in Agronomy
- B12B, Progress in Wheat Investigations. 1911. Clifford Willis, Agronomist and W. L. Burlison, Chief Asst. in Agronomy
- B133, Alfalfa as a Field Crop in South Dakota. 1912. Albert N. Hume, Agronomist and Samuel Garver, Assistant Agronomist
- B135, Trials with Millets and Sorghums for Grain and Hay in South Dakota. 1912. Albert N. Hume, Agronomist and Manley Champlin, Assistant in Crops
- B139, Soil and Crop and Their Relation to State Building. 1912. Albert N. Hume, Agronomist
- B140, Selection and Preparation of Seed Potatoes. 1913. Albert N. Hume, Agronomist and Manley Champlin, Assistant in Crops
- B141, Cooperative Tests of Alfalfa from Siberia and European Russia. 1913. N. E. Hansen, Horticulturalist
- B142, Sugar Beet Culture. 1913. James H. Shepard, Chemist
- B145, A Report of Progress in Soil Fertility Investigations. 1913. Joseph Gladden Hutton, Assistant Chief in Agronomy
- B146, Some Varieties and Strains of Wheat and Their Yields in South Dakota. 1913. Albert N. Hume, Agronomist and Manley Champlin, Assistant Agronomist
- B149, Some Varieties and Strains of Oats and Their Yields. 1914. Albert N. Hume, Agronomist and Manley Champlin, Assistant Agronomist
- B150, Weeds. 1914. H. S. Coe, Consulting Botanist
- B151, Trials with Sweet Clover as a Field Crop. 1914. Albert N. Hume, Agronomist and Manley Champlin, Assistant Agronomist
- B153, Selecting and Breeding Corn for Protein and Oil. 1914. Albert N. Hume, Agronomist, Manley Champlin, Asst. Agronomist and Howard Loomis, Agronomy Analyst
- B155, Selection and Preparation of Seed Potatoes. 1914. Albert N. Hume, Agronomist, Manley Champlin, Asst. Agronomist and I. S. Oakland, Assistant Agronomist
- B159, Progress in Plant Breeding. 1915. N. E. Hansen, Horticulturalist
- B162, First Annual Report of Vivian. Experiments and Demonstrations Farm. 1915. Albert N. Hume, Agronomist, Manley Champlin, Asst. Agronomist and J. G. Hutton, Assoc. Agronomist
- B163, Comparative Yields of Hay. 1915. Albert N. Hume, Agronomist and Manley Champlin, Assistant Agronomist
- B167, Transplanting Alfalfa. 1916. N. E. Hansen, Horticulturalist
- B169, Flax Culture in South Dakota. 1916. Albert N. Hume, Agronomist, Manley Champlin, Asst. Agronomist and John Martin,
- B170, Quackgrass and Western Wheat Grass. 1916. Albert N. Hume, Agronomist and Sam Sloan, Student Assistant in Agronomy
- B173, Sugar Beets in South Dakota. 1917. James H. Shepard, Chemist and R. C. Sherwood, Assistant Chemist
- B174, Sorghums for Forage in South Dakota. 1917. Manley Champlin, Assistant Agronomist and George Winwright, Asst. Agronomist
- B176, Potato Culture in South Dakota. 1917. Manley Champlin, Assistant Agronomist and George Winwright, Asst. Agronomist
- B179, Emmer in South Dakota. 1918. Manley Champlin, Assistant Agronomist and J. D. Morrison, Scientific Assistant (detailed by USDA)
- B180, Root Crop Culture in South Dakota. 1918. Manley Champlin, Assistant Agronomist and George Winwright, Asst. Agronomist
- B181, Corn Culture in South Dakota. 1918. Manley Champlin, Assistant Agronomist and George Winwright, Asst. Agronomist
- B183, Barley Culture in South Dakota. 1919. Manley Champlin, Associate Agronomist, J. D. Morrison, and John Martin
- B184, Yields from Two Systems of Corn Breeding. 1919. A. N. Hume, Agronomist
- B186, Corn Families of South Dakota. 1919. A. N. Hume, Agronomist
- B187, The Influence of Length of Wheat Heads on Resulting Crops. 1919. A. N. Hume, Agron., Manley Champlin, Assoc. Agron., and Matthew Fowlds, Asst. Agron.
- B193, Soybeans in South Dakota. 1921. Arthur T. Evans, Associate Agronomist and Matthew Fowlds, Assistant Agronomist
- B194, Acme Wheat. 1921. Manley Champlin, Assoc. Agronomist and Edgar McFadden,
- B196, Potatoes in South Dakota. 1922. Arthur T. Evans, Assoc. Agronomist, George Janssen, and Matthew Fowlds, Asst. Agron.
- B200, Winter Wheat in South Dakota. 1922. Arthur T. Evans, Associate Agronomist and George Janssen, Asst. Agronomist
- B201, Some Experiments with Spring Wheat in South Dakota. 1922. A. N. Hume, Agronomist, and Arthur T. Evans, Associate Agronomist
- B204, Varieties of Corn for South Dakota. 1923. A. N. Hume, Agronomist
- B205, Some Tentative Statements Concerning Fowlds Hulless Oats. 1924. A. N. Hume, Agronomist
- B211, Weeds and Their Control. 1924. E. J. Petry, Consulting Botanist
- B213, Growing Flax in South Dakota. 1925. A. N. Hume, Agronomist, E. W. Hardies, and C. J. Franzke
- B220, The Date of Seeding Winter Rye. 1926. A. N. Hume, Agronomist, E. W. Hardies and C. J. Franzke
- B222, Wheat in South Dakota. 1927. E. W. Hardies, and A. N. Hume, Agronomist
- B227, Spring Seeding Time for Wheat, Oats, Barley and Flax in South Dakota. 1927. A. N. Hume, Agronomist, Clifford Franzke and E. W. Hardies
- B230, Better Oats for South Dakota. 1928. E. W. Hardies
- B234, South Dakota Potatoes. 1928. V. R. Wertz
- B245, The Possibility of Utilizing Selfed Strains in Practical Corn Improvement. 1930. A. N. Hume, Agronomist
- B251, Combining Grain in Weed-Free Fields. 1930. D. E. Wiant, and R. L. Patty
- B253, A Decade of Crop Yields from Vivian Farm. 1930. A. N. Hume
- B256, Barley Production in South Dakota. 1930. K. H. W. Klages

- B265, A Comparison of Alfalfa, Sweetclover, and Sudangrass as Pasture Crops for Dairy Cows. 1931. Tom Olson and Ben L. Robinson
- B268, Spring Wheat Varieties for South Dakota. 1931. K. H. W. Klages
- B272, Crop Yields over Nineteen Years from Highmore Experiment Farm. 1932. A. N. Hume.
- B275, The Germination of Seed Corn. 1933. A. N. Hume and Clifford Franzke
- B276, Winter Wheat Production in South Dakota. 1933. K. H. W. Klages
- B280, The Results of Twenty Years Complete Soil Fertility Tests at Brookings, SD. 1933. J. G. Hutton
- B281, Oat Feed as a Substitute for Roughage. 1933. Tom Olson
- B285, Sorghums for Forage and Grain in South Dakota. 1934. A. N. Hume and Clifford Franzke
- B291, Small Grain and Flax Varieties in South Dakota. 1934. K. H. W. Klages
- B299, Hybrid Corn. 1936. A. N. Hume and Clifford Franzke
- B303, The Two Row Cultivator Converted into a Weed Control Machine. 1936. D. E. Wiant, and R. L. Patty
- B305, Field Bindweed. 1936. C. J. Franzke and A. N. Hume
- B312, Twenty-One Years of Crop Yields from Cottonwood Experiment Farm. 1937. A. N. Hume, Edgar Joy and Clifford Franzke
- B314, A Preliminary Study of the Effect of Cultivation on Certain Chemicals and Physical Properties of Some South Dakota Soils. 1937. Leo F. Puhr and Oscar Olson
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- B645, How an Oat Plant Develops. 1976. D. L. Reeves and H. S. Sraon
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- TB34, Pasture Improvement.
- TB35, Diseases of Grasses and Cereals in South Dakota. A check list. 1969. C. J. Mankin
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- TB41, Nematodes of the Northern Great Plains. Part II. Dorylaimoides (Nemata: Adenophorea). 1974. Gerald Thorne

Circulars

Experiment Station circulars were extension-type publications for widespread distribution to farmers and ranchers. At first they contained recommendations, but in later years they were used as annual reports of Experiment Farms or Performance Testing. Circular No. 1 and 83 others (36%) of the Experiment Circulars were written by Agronomists.

- C 1, Soil Survey (reprint in 1933). J. G. Hutton
- C32, Miomark Oats. 1941. S. P. Swenson
- C43, Seed Testing on the Farm. 1943. E. L. Erickson
- C45, The 1942 South Dakota Hybrid Corn Yields. 1943. E. R. Hehn and J. E. Grafius
- C50, South Dakota Corn Performance Testing in 1943. 1944. J. E. Grafius and E. R. Hehn
- C51, Sorghum Seed Treatment. 1944. W. M. Buchholtz
- C55, South Dakota Corn Performance in 1944. 1944. Karl F. Manke and J. E. Grafius
- C57, Rancher Sorghum. 1945. C. J. Franzke
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- C67, Feebar Barley. 1947. J. E. Grafius
- C69, Chemical Control of Weeds. 1949. L. M. Stahler, Lyle A. Derscheid and D. E. Kratochvil
- C71, 1947 Corn Performance Test. 1948. D. B. Shank

Technical Bulletins

Starting in 1939 technical bulletins were used for reporting more technical types of research. Members of the Agronomy and Plant Pathology Departments authored 17 of the first 41 technical bulletins published.

- TB1, A Study of Sorghum with Reference to the Content of HCN. 1939. C. J. Franzke, Leo F. Puhr and A. N. Hume
- TB2, A Selenium in Rocks, Soils and Plants (Revised 1950)

- C74, Plains Barley. 1950. J. E. Grafius
- C75, Cultural Methods of Noxious Weed Control in South Dakota. 1948. L. M. Stahler and Lyle A. Derscheid
- C76, Corn Performance in 1948. 1949. D. B. Shank
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- C81, Grasses and Legumes for South Dakota. 1950. M. W. Adams, J. G. Ross, W. W. Worzella and A. N. Hume
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- C88, Soils of South Dakota. 1951. F. C. Westin, A. J. Klingelhoets and G. B. Lee
- C89, Preliminary Experiments With Vapor Treatments for Prevention of Stinking Smut of Wheat. 1940. C. M. Nagel and L. R. Richardson
- C92, Fertility Maintenance and Management of South Dakota Soils. 1952. Leo F. Puhr and W. W. Worzella
- C93, Corn Performance Test in 1951. 1952. G. E. Nachtigal and D. B. Shank
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- C102, Perennial and Annual Weed Control in South Dakota. 1954. Lyle A. Derscheid and Lloyd R. Wilson
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- C104, Soil Moisture Depletion by Irrigated Crops Grown in South Dakota. 1954. Leonard J. Erie and Neil A. Dimick
- C107, Irrigation Research in the James River Basin; A 5-year progress report. 1954. Different sections by different authors
- C109, Soil Survey and Land Valuation for Tax Purposes. 1954. A. J. Klingelhoets and F. C. Westin
- C112, 1954 Corn Performance Test. 1955. D. E. Kratochvil and D. B. Shank
- C113, Research in Crops and Soils--A Progress Report. 1955. Worzella, Puhr, Franzke, Shank, Dirks, Ross, Adams, Harpstead and Hume
- C114, Chemical Control of Woody Plants. 1955. Lyle A. Derscheid and E. K. Ferrel
- C120, Fertilization and Spacing of Irrigated Corn on the Belle Fourche Irrigation Project. 1956. Bruce L. Baird and Joseph J. Bonnemann
- C121, Corn Performance Tests in 1955. 1956. D. E. Kratochvil and D. B. Shank
- C122, Weed Control Research in SD. 1956. Lyle A. Derscheid and Keith E. Wallace
- C123, Better Agriculture Through Research in South Dakota. 1956.
- C124, Agricultural Research at the Central Substation at Highmore, SD. 1956. Different sections by various authors
- C125, Weed Control Equipment. 1956. Lyle A. Derscheid and H. H. DeLong
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- C232, 1979 Grain Sorghum Performance Trials.
1980. J. J. Bonnemann

Departmental Pamphlets

Departmental pamphlets were extension-type publications on temporary topics. Originally they were used for annual reports of Performance Testing results, but were later used as progress reports or for the publication of tentative information that would later be included as part of a more permanent publication.

Agronomy Pamphlets

Over 90 pamphlets were written by members of the Agronomy Department in the quarter of a century 1944-1969.

- AP1 Agronomy Seed Laboratory, Its Functions and Service Explained. January 1944. E. L. Erickson

- AP2 1943 Crop Variety Yields and Recommendations. January 1944. J. E. Grafius, C. V. Franzke, E. L. Erickson, A. N. Hume
- AP3 Progress Report of Field Trials of Soil conservation Practices in SD from 1939-1943.
- AP4 Field Trials with Fertilizers in SD. January 1945. L. F. Puhr and W. W. Worzella
- AP5
- AP6 Field Trials with Fertilizers in SD in 1945. December 1945. W. W. Worzella and L. F. Puhr
- AP7
- AP8 Small Grain Variety Tests in SD 1941-1945. January 1946. J. E. Grafius and E. R. Hehn
- AP9 Killing Weeds with 2,4-D. April, 1946.
- AP10 Chemical Control of Weeds. January 1947. L. A. Derscheid and L. M. Stahler
- AP11 Small Grain Variety Tests in SD. 1946. J. E. Grafius
- AP12 Approved Practices for Noxious Weed Control. April 1947. L. M. Stahler and L. A. Derscheid
- AP13 Soil Testing for SD - August, 1947.
- AP14
- AP15 Progress Report of Small Grain Variety Tests in SD. 1947. J. E. Grafius
- AP16 A Method of Checking a Weed Sprayer. May 1948. Lyle A. Derscheid
- AP17 Soil Testing for SD - January, 1949.
- AP18 Small Grain Variety Tests SD 1944-1948. January, 1949. J. E. Grafius and V. A. Dirks
- AP19 Culture Methods for Grain Sorghum Seed Production. Feb. 1949. C. J. Franzke
- AP20 Small Grain Variety Tests in SD 1945-1949. Nov., 1949. J. E. Grafius, V. A. Dirks, G. Keehn, A. C. Dittman and Larson
- AP21 Progress Report of SD Fertilizer Experiments 1950. December 1950. L. F. Puhr, L. O. Fine, P. L. Carson and D. Norgaard
- AP22 Small Grain Variety Trials in SD 1946-1950. January, 1951. J. E. Grafius and V. A. Dirks
- AP23
- AP24 Progress Report of SD Fertilizer Experiments 1952. L. F. Puhr, B. L. Brage, P. L. Carson, F. E. Shubeck, E. Gresham
- AP25
- AP26 Progress Report of SD Fertilizer Experiments 1953. Puhr, Brage, Carson, Shubeck, Gresham
- AP27 Small Grain Variety Trials in South Dakota 1949-1953. Feb. 1954. V. A. Dirks and D. D. Harpstead
- AP28 The Suitability of SD Waters for Irrigation. June 1954. E. J. Williamson and P. L. Carson
- AP29 SD Fertilizer Experiments, 1954. L. F. Puhr, F. E. Shubeck, B. L. Brage, L. O. Fine and P. L. Carson
- AP30 Small Grain Variety Trials in SD 1950-1954. V. A. Dirks, D. D. Harpstead, H. Lund, A. L. Dittman, W. Pringle, J. J. Bonnemann, Osenbrug, F. Whetzal
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- AP36 Small Grain Variety Trials in SD 1952-1956. December, 1956. V. A. Dirks, D. D. Harpstead

- AP37 Southeast Research Farm, Menno, SD Annual Progress Report. December, 1956. Q. S. Kingsley
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- AP40 Small Grain Variety Trials 1953-1957. V. A. Dirks, D. D. Harpstead
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- AP44 Winter Grains Variety Trials in SD 1954-1958. V. A. Dirks
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- AP46 Corn Performance, 1958. D. B. Shank and D. E. Kratochvil
- AP47 Soil Fertility and Management Experiments, 1958. December, 1958.
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- AP49 Northeast Research Farm, Watertown, SD Annual Progress Report, 1958. Dec., 1958. Q. S. Kingsley
- AP50 South Central Research Farm, Presho. March, 1959. G. A. Geise
- AP51 Recent Legume Variety Trials in SD, July, 1959. M. D. Rumbaugh
- AP52 Southeast Research Farm, Menno, SD. Annual Progress Report, 1959. Dec., 1959. Q. S. Kingsley
- AP53 Northeast Research Farm, Watertown, SD. Annual Progress Report, 1959. Dec., 1959. Q. S. Kingsley
- AP54 South Central Research Farm, Presho. Annual Progress Report, Dec. 1959. H. A. Geise
- AP55 Small Grain Yield Trials, SD 1959. March, 1960. V. A. Dirks, D. D. Harpstead and P. B. Price
- AP56 Recent Legume Variety Trials in SD. Nov. 1960. M. D. Rumbaugh
- AP57 Oat Variety Trials in SD 1956-1960. D. D. Harpstead
- AP58 Spring Wheat Yield Trials, SD 1956-60. Nov., 1960. V. A. Dirks
- AP59 Winter Wheat and Rye Performance in SD 1956-60. V. A. Dirks and D. D. Harpstead
- AP60 Southeast Research Farm, Menno, SD. Annual Progress Report, Dec., 1960. Q. S. Kingsley
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- AP62 South Central Research Farm, Presho, SD. Annual Progress Report, Dec. 1960. H. A. Geise
- AP63 Soil Fertility and Management Field Experiments, 1959. December, 1960.
- AP64 Oat Variety Trials in SD 1957-1961. Nov., 1961. D. D. Harpstead and J. J. Bonnemenn
- AP65 Rye Variety Trials in SD 1957-1961. Nov. 1961. D. D. Harpstead
- AP66 Flax Variety Trials in SD 1957-1961. Dec., 1961. D. D. Harpstead
- AP67 SD Corn Performance Trials. Dec., 1961. J. J. Bonnemenn and R. Carlson
- AP68 Recent Legume Variety Trials in SD. January, 1962. M. D. Rumbaugh
- AP69 The Genetics of Reaction of Alfalfa to Diseases of the Blackstem Complex. January, 1962. M. D. Rumbaugh, Tamimi, H. A. Geise, G. Semenik
- AP70 Southeast SD Exp. Farm, SD Ann. Prog. Rep., Dec., 1961.
- AP71 NE Research Farm. Ann. Prog. Rep. Dec., 1961. Q. S. Kingsley
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- AP93 Secondary and Micronutrient Fertilizer Experiments 1966, 1967 and 1968. R. C. Ward, L. O. Fine, Deibert, E. J. Langin and P. L. Carson

Plant Science Pamphlets

In 1969 when the Agronomy Department and Plant Pathology Departments were merged into the Plant Science Department, the name of the pamphlets were changed from Agronomy Pamphlet to Plant Science Pamphlet. Fifty-two publications were written during the next 10 years.

- PSP1 Soil Fertility Experiments, 1968. Small Grain, Corn, Alfalfa, Grass.
- PSP2 South Central Research Farm. Ann. Prog. Rep., Dec., 1969. H. A. Geise
- PSP3 Northeast Research Farms. Annual Progress Report., Dec. 1969. Q. S. Kingsley

- PSP4-A Whetstone Valley Research Farm. Ann. Prog. Rep., Dec., 1969. Q. S. Kingsley
- PSP4-B South Dakota Land Inventory, July 1970.
- PSP5 Northeast Research Farms. Annual Progress Report, Dec. 1970. Q. S. Kingsley
- PSP6 South Central Research Farm. Annual Progress Report., Dec. 1970. H. A. Geise
- PSP7 South Dakota Forage Legume Variety Trials: 1941-1970. July 1, 1971.
- PSP8 NE Research Farms. Annual Progress Report. Dec., 1971. Q. S. Kingsley
- PSP9 South Central Research Farm. Annual Progress Report, Dec. 1971. H. A. Geise
- PSP10 1972 Standard Variety Small Grain Trials. Dec., 1972. J. J. Bonnemann
- PSP11 NE Research Far, West Prairie Coteau, Garden City, North Sioux Valley, Watertown and Whetstone Valley, Twin Brooks. Dec. 1972. Q. S. Kingsley
- PSP12 South Central Research Farm. Annual Progress Report. Dec., 1972. H. A. Geise
- PSP13 1973 Standard Variety Small Grain Trials. Nov., 1973. J. J. Bonnemann
- PSP14 Central Crops and Soils Research Station, Ann. Prog. Rep., Dec. 1973. H. A. Geise
- PSP15 South Central Research Farm. Annual Progress Report., Dec. 1973. H. A. Geise
- PSP16 Sunflower Variety Trials. Dec., 1973.
- PSP17 Sorghum Forage Trials. Dec. 1973 H. A. Geise
- PSP18 1974 Standard Variety Small Grain Trials. Nov. 1974. J. J. Bonnemann
- PSP19 Central Crops and Soils Research Station., Highmore, Ann Prog Rep, Dec. 1974. Q. S. Kingsley
- PSP20 Soil Fertility Experiments, 1969. Small Grain, Corn, Alfalfa, Grass.
- PSP21 1975 Standard Variety Small Grain Trials. Nov., 1975. J. J. Bonnemann
- PSP22 Alfalfa Performance Trials 1972-1975. Dec., 1975. J. J. Bonnemann, M. D. Rumbaugh, and J. R. Johnson
- PSP23-A Central Crops and Soils Research Station, Ann Prog Rep., Dec. 1975. Q. S. Kingsley
- PSP23-B Soils of the North Plots on the Plant Pathology Farm. Dec. 3, 1975. D. D. Malo and F. C. Westin
- PSP24 West River Agric. Res. & Ext. Center, Crops and Soils Research. Dec., 1974. Ann. Prog. Rep. H. A. Geise and J. R. Johnson
- PSP25 West River Agric. Res. & Ext. Center, Crops and Soils Research, Rapid City, SD. Dec., 1975. Annual Progress Report. H. A. Geise and J. R. Johnson
- PSP26 Soil Test Results on Selected Soil Samples from Fall River County, SD. June 14, 1976. D. D. Malo
- PSP27 Central Crops and Soils Research Station, Ann Prog Rep. Dec., 1976. Q. S. Kingsley
- PSP28 1976 Standard Variety Small Grain Trials. Nov. 1976. J. J. Bonnemann
- PSP29 1976 Soybean Performance Trials. Nov., 1976. J. J. Bonnemann, G. W. Erion, A. O. Lunden
- PSP30 Sunflower Studies in South Dakota. Ann. Prog. Rep., Dec., 1976. Q. S. Kingsley
- PSP31 Butte County Irrigated Alfalfa Demonstration Project. 1976 Prog. Rep., Jan., 1977. J. R. Johnson
- PSP32 West River Agr. Res. and Ext. Center, Crops and Soils Research. Ann. Prog. Rep., Dec., 1976. H. A. Geise and J. R. Johnson
- PSP33 Alfalfa Performance Trials 1972-1976. April, 1977. J. J. Bonnemann, M. D. Rumbaugh, B. Johnson
- PSP34 Fertilizer Guide for Soil Test -- Computerized Recommendations, June 1977. R. Gelderman, E. P. Adams, E. J. Williamson, P. L. Carson
- PSP35 1977 Standard Variety Small Grain Trials. Nov., 1977. J. J. Bonnemann
- PSP36 1977 Soybean Performance Trials. Jan., 1978. J. J. Bonnemann, G. W. Erion
- PSP37 West River Agric. Res. & Ext. Center, Crops and Soils Research. Annual Progress Report, Dec. 1977. H. A. Geise and J. R. Johnson
- PSP38 Central Crops and Soils Research Station, Highmore, SD. Annual Progress Report, Dec. 1977. Q. S. Kingsley
- PSP39 Sunflower Studies in South Dakota. Annual Progress Report., Dec. 1977.
- PSP40 Alfalfa Performance Trials 1972-1977. Feb., 1978. J. J. Bonnemann, G. L. Holborn and J. R. Johnson
- PSP41 Explanation of Soil Test Recommendations. P. L. Carson, R. Gelderman, E. P. Adams, E. J. Williamson
- PSP42 Plant Analysis Procedures in use at the South Dakota State Soil Testing and Plant Analysis Laboratory, 1978.
- PSP43 Butte County Irrigated Alfalfa Demonstration Project, 1977 Progress Report. J. R. Johnson, Hewlett, Larson.
- PSP44 1978 Standard Variety Small Grain Trials. Nov., 1978. J. J. Bonnemann
- PSP45 1978 Soybean Performance Trials. Dec., 1978. J. J. Bonnemann, G. W. Erion
- PSP46 Central Crops and Soils Research Station, Ann. Prog. Rep., Dec., 1978. Q. S. Kingsley
- PSP47 Alfalfa Performance Trials 1972-1978. Dec., 1978. J. J. Bonnemann and G. L. Holborn
- PSP48 Sunflower Studies in South Dakota. Annual Progress Report., Dec. 1978.
- PSP49 West River Agric. Res. & Ext. Center, Crops and Soils Research. Dec. 1978. H. A. Geise and J. R. Johnson
- PSP50 1978 Standard Variety Small Grain Trials. Nov., 1979. J. J. Bonnemann and H. A. Geise
- PSP51 1979 Soybean Performance Trials. Dec., 1979. J. J. Bonnemann and G. W. Erion
- PSP52 West River Agric. Res. & Ext. Center, Crops and Soils Research, Rapid City, SD. Dec. 1979. H. A. Geise and C. E. Stymiest

EXTENSION PUBLICATIONS

Many of the early Experiment Station bulletins were written for use by farmers much the same as Extension Service publications are today. Those bulletins were printed and perhaps could not be produced as quickly or as cheaply as Extension specialists desired. For material that was to have limited distribution they used the hectograph, mimeograph and in later years the xerox. Bulletin room records indicate that 99 publica-

tions of this type were produced prior to 1936 and 775 since that date.

Extension Leaflets were printed publications that were used for publications that were prepared for wide distribution. It could not be determined when this publication was first used, but it was rather widely used during the late 1940s and 1950s. About 200 publications were printed prior to 1960.

Experiment Station circulars were initiated in 1933 for use by research staff to publish information for use by farmers. They were used extensively by agronomists.

In 1959 the format of Extension publications was changed. Extension Leaflets were about 99% replaced by fact sheets, and several Experiment Station circulars were reproduced as fact sheets.

Extension Mimeographed Circulars

Extension agronomists used the mimeograph to reproduce hundreds of reports and other types of information that did not receive an EMC number. They apparently numbered about 3 dozen reports between 1940 and 1960. In the mid-1970s, when the Extension editors obtained equipment to "offset" typewritten copy, EMC numbers were put on several publications that would have limited distribution and be revised in the near future.

EMC 149 Conservation and Natural Resources
EMC 153 Pasture Crops for South Dakota.
EMC 164 Hard Red Spring Wheat.
EMC 173 South Dakota Weed Problem. 1938
EMC 175 Handbook for Range Examiners.

EMC 176 Corn and Wheat--AAA Questions.
EMC 178 Sorghum in South Dakota.
EMC 183 Sorghum and Corn Demonstration Plots.
EMC 200 Hybrid Corn. 1938.
EMC 201 Small Grain Demonstration Plots.

EMC 209 Creeping Jenny Control.
EMC 309 Growing Field Beans.
EMC 311 Leafy Spurge.
EMC 323 Grasses and Legumes.
EMC 327 Crops for Summer Seeding.

EMC 328 Combining and Threshing Grass Seed.
EMC 340 Winter Wheat Varieties. 1945.
EMC 343 Soil Conservation. 1945.
EMC 354 Alfalfa Seed and Hay Production.
EMC 355 Winter Rye Varieties. 1946.

EMC 369 Outline of Soil Conservation Activities. 1947.
EMC 374 Grass and Other Range and Pasture Plants.
EMC 376 Value of SCS Practices in 1949.
EMC 414 Grass and Other Range and Pasture Plants.
EMC 420 Value of SCS Practices in 1950.

EMC 424 Drought & Heat Injured Corn - Valuable Feed. 1955.
EMC 430 Hybrid Sorghum Information. 1956.
EMC 432 Description of Crop Varieties. 1955.
EMC 442 Growing Soybeans. 1957.
EMC 444 Sorghum Production. 1957.

EMC 445 Sudan Grass--Supplemental Forage. 1957.
EMC 463 Establish & Maintain Grass & Legume Stands.
EMC 473 Soils: Development & Management.
EMC 481 Summary of Preemergence Weed Control.
EMC 501 Fertilizer Response on Demo Farms.

EMC 505 4-H Soil Sampling Activity. 1959.
EMC 506 4-H Soil Productivity. 1959.
EMC 515 Pastures of Eastern South Dakota. 1959.
(Replaced by FS 42).
EMC 516 4-H Members & Leaders Project Guide-Range.
EMC 520 One-Way Disc-Plow Operation (Replaced by FS501).

EMC 529 Summary-Soil Management and Irrigation Research.
EMC 629 Soils and Fertilizer Guide.
EMC 640 Sorghum Varieties and Hybrids (Replaced by 739).
EMC 650 Market Prices-Net Profit--ESE SD 1974.
EMC 641 " " " " --WSE SD "

EMC 652 " " " " --NE SD "
EMC 653 " " " " --ENC SD "
EMC 654 " " " " --NC SD "
EMC 655 " " " " --SC SD "
EMC 658 Agronomic Value of Manure and Sludge.

EMC 659 Nitrogen Recommendations for Corn in ESD.
EMC 661 Evaluation of Soils Tests in Deuel Co.
EMC 662 Comfrey.
EMC 670 Market Prices-Net Profit--ESE SD 1975.
EMC 671 " " " " --WSE SD "

EMC 672 " " " " --NE SD "
EMC 673 " " " " --ENC SD "
EMC 674 " " " " --NC SD "
EMC 675 " " " " --SC SD "
EMC 676 New Label for Picloram (Replaced by FS 639).

EMC 678 1978 Crop Herbicide Test Results, etc.
EMC 681 Weed Control in Sunflowers (Replaced by FS 652).
EMC 708 Fertilizing Sunflowers.
EMC 708 Lawn and Turf Herbicides.
EMC 709 Using Drought Damaged Corn. 1976.

EMC 720 Market Prices-Net Profit--ESE SD 1976.
EMC 721 " " " " --WSE SD "
EMC 722 " " " " --NE SD "
EMC 723 " " " " --ENC SD "
EMC 724 " " " " --NC SD "

EMC 725 " " " " --SC SD "
EMC 739 Sorghum Varieties and Hybrids (Replaced by FS775).
EMC 743 Location & Retail Price of Forage Crop Seed. 1977.
EMC 751 Description of Hard Red Spring Wheat Varieties. 1977.
EMC 752 Descriptions of Oats Varieties. 1977.

EMC 775 Sorghum Varieties and Hybrids.
EMC 778 Hessian Fly in South Dakota.
EMC 780 Market Prices-Net Profit--ESE SD 1977.
EMC 781 " " " " --WSE SD "
EMC 782 " " " " --NE SD "

EMC 783 " " " " --ENC SD "
EMC 784 " " " " --NC SD "
EMC 785 " " " " --SC SD "
EMC 804 Alfalfa Variety Descriptions. 1979.

Extension Leaflets

Judging from the title, it would appear that Extension leaflets were written as early as the 1920s, however, Extension agronomists only published 17 before 1950 and 15 between 1950 and 1960.

EL 26 Good Seed Corn - How to Select and Store it.
EL 27 Soybeans in South Dakota (Replaced by 58).
EL 28 Sweetclover in South Dakota.
EL 41 Crops.
EL 52 Flax. (Replaced by 196).

EL 55 Sorghum Production.
EL 58 Soybeans in South Dakota. (Replaced by 217).

- EL 55 Pastures and Your Cheapest Feed.
- EL 81 Your Soil Conservation District Can Help You.
- EL 86 Soybeans. (Replaced by FS 2).
- EL 89 Treat Seed Grains.
- EL 93 Crops for Summer Seeding. (Replaced by 128).
- EL 96 Starving and Poisoning Creeping Jenny.
- EL 110 Stem Rust. 1948.
- EL 118 Weed Control Methods.
- EL 121 Flax-Growers Guide for South Dakota.
- EL 122 Spraying 2,4-D in Drops.
- EL 124 Farming in the 1950s. 1950.
- EL 127 Norghum Sorghum. 1950.
- EL 128 Crops for Summer Seeding. (Replaced by FS 1).
- EL 132 Soft Corn. 1950.
- EL 142 Chemical Control of Weeds. 1952.
- EL 148 Preventing Weeds.
- EL 154 Perennial Weed Control
- EL 155 Chemical Weed Control in Crops. 1954.
- EL 156 Checking Weed Sprayers (Replaced by FS 342).
- EL 165 How Clean is Your Seed?
- EL 167 Field Crop Varieties for 1957. (Replaced by 174).
- EL 174 Crop Varieties for South Dakota in 1958. (Replaced by 197).
- EL 175 South Dakota Grain Grows Clean.
- EL 177 Chemical Weed Control in Crops (Replaced by FS 5).
- EL 178 Perennial Weed Control. 1956.
- EL 196 Flax Production in South Dakota. (Replaced by FS 112).
- EL 197 Field Crop Varieties for 1959. (Replaced by FS 6).

Experiment Station Publications

More than a score of Experiment Station circulars written by agronomists were written for distribution to farmers. They include circulars 1, 32, 43, 51, 57*, 58*, 67*, 69, 74*, 75, 81, 94, 102, 114*, 122, 125*, 146**, 147**, 148**, 157 and 168*. Those indicated with an asterisk are still being used as Extension-type publications and those with two asterisks were converted to fact sheets.

Likewise, most of the pamphlets listed earlier were written by research staff to be used as Extension publications.

Extension Circulars

- EC 3 Destroy the Common Barberry.
- EC 33 Barberry Eradication.
- EC 79 Cropping Systems.
- EC 92 History of Corn.
- EC 101 Corn Groups and Varieties.
- EC 102 Description of the Corn Plant.
- EC 110 Cereals.
- EC 114 Definite Corn Breeding Plots.
- EC 120 Soil and Seedbed for Corn.
- EC 122 Planting the Corn Crop.
- EC 123 Selecting & Preparing Seed for Breeding Plot.
- EC 124 Selecting and Planting the Corn Breeding Plot.
- EC 125 Selecting and Treating Seed Potatoes.
- EC 126 Planting the Potato Crop.

- EC 128 Cultivating the Corn Crop.
- EC 129 Care of the Corn Breeding Plot.
- EC 131 Cultivating the Potato Crop.
- EC 139 Late Summer Care of Corn.
- EC 140 Corn Diseases and Insects.
- EC 146 Harvesting, Storing and Marketing the Corn Crop.
- EC 147 Harvesting the Corn Breeding Plot.
- EC 148 Harvesting, Storing and Marketing the Potato Crop.
- EC 149 Field Selection and Storage of Seed Corn.
- EC 150 Field Selection of Seed Potatoes.
- EC 193 Alfalfa in South Dakota.
- EC 202 Alfalfa Seed Production in South Dakota.
- EC 240 Black Stem Rust and Common Barberry.
- EC 241 Wheat for Profit.
- EC 248 Quality of Alfalfa Seed.
- EC 249 Feed Crops for Late Planting.
- EC 251 South Dakota Cereals.
- EC 258 Sweetclover for Profit.
- EC 259 Alfalfa for Livestock
- EC 293 Flax Facts.
- EC 306 Supplement to Flax Facts.
- EC 364 Agricultural Conservation Program Handbook.
- EC 368 Five Noxious Weeds in South Dakota.
- EC 376 Soil Conservation. 1943.
- EC 392 How to Farm on the Contour.
- EC 397 Planting Windbreaks . . .
- EC 407 Crop Test Varieties.
- EC 416 Recommended Crop Varieties.
- EC 436 Soil--Management and Conservation.
- EC 449 South Dakota's Crop Varieties.
- EC 454 South Dakota's Noxious Weeds. 1947.
- EC 474 Crop Varieties.
- EC 505 Fertilizer Recommendations . . .
- EC 542 Soil Bank.
- EC 547 Organizing Watersheds . . . (Replaced by 619).
- EC 550 Facts About The Great Plains Conservation Program.
- EC 586 Know Your Land Program.
- EC 619 Organizing Watersheds . . . 1963.
- EC 654 Irrigation: Your Water, Soil . . . 1967.
- EC 655 Irrigation Costs and Returns. 1967. (Replaced by 661).
- EC 656 South Dakota's Billion Dollar Agriculture. 1967.
- EC 660 Soil Atlas & Crop Production Guide-N.C. S.D. 1968.
- EC 661 Irrigation Costs and Returns. 1968. (Replaced by 680).
- EC 680 " " " " 1969.
- EC 684 Soil Atlas and Crop Production Guide-N.E. S.D. 1969.
- EC 691 Soils and Fertilizer Guide. 1973.
- EC 703 Conservation Tillage. 1975.
- EC 709 Alternative Pasture and Forage Systems. 1976.
- EC 730 Irrigated Alfalfa in South Dakota. 1980.
- EC 733 Alfalfa Seed Production. 1981.
- EC 772 Alfalfa an Economic Alternative to Corn? 1979.

Fact Sheets

In 1959 the format of Extension publications was changed. Fact sheets replaced leaflets and many Experiment Station circulars.

- FS 1 Crops for Summer Seeding. 1959. (Replaced by 312).
- FS 2 Growing Soybeans in South Dakota. 1959. (Replaced by 249).
- FS 5 Chemical Weed Control in Crops. 1960. (Replaced by 44).
- FS 6 Field Crop Varieties for 1960. (Replaced by 41).
- FS 7 Oats Production in South Dakota. 1960. (Replaced by 45).
- FS 8 Barley Production. 1960. (Replaced by 106).
- FS 9 Sorghum Production. 1960. (Replaced by 43).
- FS 12 Fertilizer Recommendations--Eastern S.D. 1960. (Discontinued).
- FS 13 Fertilizer Recommendations--Western S.D. 1960. (Discontinued).
- FS 16 Hard Seeds in Legumes. 1960.
- FS 20 Control and Elimination of Thistles. 1960. (Replaced by 281).
- FS 21 Control and Elimination of Russian Knapweed. 1960. (Replaced by 144).
- FS 22 Control and Elimination of Leafy Spurge. 1960. (Replaced by 117).
- FS 25 Control and Elimination of Field Bindweed. 1960. (Replaced by 251).
- FS 27 Sudangrass for Supplemental Forage. 1960. (Replaced by 589).
- FS 34 Know Your Fertilizer. 1960. (Replaced by 250).
- FS 40 Developing South Dakota Watersheds. 1960. (Replaced by 359).
- FS 41 Field Crop Varieties. 1961. (Replaced by 104).
- FS 42 Grassland Legume Pastures in Eastern S.D. 1961. (Replaced by 257).
- FS 43 Sorghum Production. 1961. (Replaced by 252).
- FS 44 Chemical Weed Control in Crops. 1961. (Replaced by 115).
- FS 45 Oats Production in South Dakota. 1961. (Replaced by 105).
- FS 47 Produce Quality Spring Wheat. (Replaced by 193).
- FS 51 Control and Elimination of Quackgrass. 1961. (Replaced by 364).
- FS 52 Chemical Weed Control in Trees. 1961. (Replaced by 109).
- FS 53 Sugar Beets in South Dakota. 1961. (Discontinued).
- FS 64 Harvesting Native Grasses. 1961. (Replaced by 581).
- FS 69 Fertilizing Corn in Eastern S.D. 1961. (Replaced by 248).
- FS 88 Soils, Water and Drainage of Oahe Project Lands. 1961. (Discontinued).
- FS 104 Field Crop Varieties. 1962. (Replaced by 150).
- FS 105 Oats Production in South Dakota. 1962. (Replaced by 267).
- FS 106 Barley Production. 1962. (Replaced by 301).
- FS 109 Chemical Weed Control in Trees. 1962. (Replaced by 190).
- FS 112 Flax Production in South Dakota. 1962. (Replaced by 300).
- FS 115 Chemical Weed Control in Crops. 1962. (Replaced by 155).
- FS 116 Control and Elimination of Noxious Weeds. 1962. (Replaced by 274).
- FS 117 Control and Elimination of Leafy Spurge. 1962. (Replaced by 181).
- FS 118 Fertilizing Small Grain in South Dakota. 1962. (Replaced by 325).
- FS 119 Control and Elimination of Wild Oats. 1962. (Replaced by 410).
- FS 124 Preemergence Weed Control on Crops. 1962. (Discontinued).
- FS 128 Sugar Beets in Eastern South Dakota. 1962. (Discontinued).
- FS 130 Dutch Elm Disease. 1962. (Replaced by 326).
- FS 134 A. South Dakota Soils. B. (Discontinued). C. South Dakota Soils.
- FS 144 Control and Elimination of Russian Knapweed. 1962.
- FS 148 Preemergence Crabgrass Control. 1962. (Replaced by 419).
- FS 150 Field Crop Varieties. 1963. (Replaced by 179).
- FS 154 Producing Oats for Milling. 1963. (Replaced by 380).
- FS 155 Chemical Weed Control. 1963. (Replaced by 443).
- FS 159 Farming Claypan Soils in South Dakota. 1964.
- FS 162 Organizing Irrigation Districts. 1964.
- FS 179 Field Crop varieties for 1964. (Replaced by 264).
- FS 181 Control and Elimination of Leafy Spurge. 1964. (Replaced by 449).
- FS 182 Pure Live Seed. 1964.
- FS 184 Weed Control in Small Grains. 1964. (Replaced by 338).
- FS 185 Weed Control in Corn. 1964. (Replaced by 305).
- FS 186 Planting Corn in South Dakota. 1964. (Replaced by 523).
- FS 189 Forage Crop Production Guide. 1964. (Replaced by 202, 273, 292, 293).
- FS 190 Chemical Weed Control in Trees. 1963. (Replaced by 303).
- FS 192 Chemical Weed Control in Crops. 1964. (Replaced by 275).
- FS 193 Seed Treatment--Small Grain and Other Field Crops. 1964. (Discontinued).
- FS 194 Spring Wheat Production. 1964. (Replaced by 346).
- FS 196 Pasm of Flax. 1964
- FS 197 Corn Smut. 1964
- FS 198 Stalk Rot of Corn. 1964.
- FS 199 Ear Rot of Corn. 1964.
- FS 200 Corn Leaf Blight. 1964.
- FS 202 Small Grain Production Guide. 1964. (Replaced by 270).
- FS 205 Oahe Intermediate Wheatgrass. 1964. (Discontinued).
- FS 220 "Proper" Range Use. How Do I Rate Use on My Own Native Pastures. 1964. (Discontinued).
- FS 221 Plant a Tame Pasture? Or Reseed Native Grasses? 1964. (Discontinued).
- FS 222 Range Seedings: Kinds that Succeed and Kinds that Fail. 1964. (Discontinued).
- FS 223 Graze Longer and Feed Less: Systems to Balance Native and Tame Pastures With Seasonal Needs. 1964. (Discontinued).
- FS 224 My Rangelands: What Kinds? How Good? 1964. (Discontinued).
- FS 248 Fertilizing Corn in South Dakota. 1964. (Replaced by 297).

- FS 249 Growing Soybeans in South Dakota. 1964. (Replaced by 347).
- FS 250 Fertilizer Facts. 1964. (Replaced by 557).
- FS 251 Control and Elimination of Field Bindweed. 1965. (Replaced by 306).
- FS 252 Sorghum: Production, Varieties, Fertilization. 1965. (Replaced by 308).
- FS 255 Pastures for Maximum Production. 1965. (Replaced by 307).
- FS 256 Improving 'Worn Out' Pastures. 1965. (Replaced by 295).
- FS 257 Planting Tame Pastures and Haylands. 1965. (Replaced by 503).
- FS 259 Safe Use of Pesticides. 1965.
- FS 261 Weed Control in Sorghum. 1965. (Replaced by 304).
- FS 264 Field Crop Varieties for 1965. (Replaced by 329).
- FS 267 Oats Production in South Dakota. 1965. (Replaced by 384).
- FS 270 Small Grain Production Guide. 1965. (Replaced by 294).
- FS 273 Corn Production Guide. 1965. (Replaced by 291).
- FS 274 Control and Elimination of Noxious Weeds. 1965. (Replaced by 448).
- FS 275 Chemical Weed Control in Crops. 1965. (Replaced by 443).
- FS 281 Control and Elimination of Thistles. 1965. (Replaced by 450).
- FS 291 Corn Production Guide. 1965. (Replaced by 334).
- FS 292 Sorghum and Soybean Production Guide 1966. (Replaced by 336).
- FS 293 Forage Crop Production Guide. 1966 (Discontinued).
- FS 294 Small Grain Production Guide. 1966. (Replaced by 335).
- FS 295 Interseeding Pastures. 1966. (Replaced by 422).
- FS 297 Fertilizing Corn. 1966. (Replaced by 432).
- FS 298 Native Grasses for Pasture or Hay. 1966. (Replaced by 547 and 548).
- FS 299 Tame Grasses for Pasture or Hay. 1966. (Replaced by 546, 547, 548, 549).
- FS 300 Flax Production. 1964. (Replaced by 488).
- FS 301 Barley Production. 1964. (Replaced by 485).
- FS 302 Grazing Management Based on How Grasses Grow. 1966.
- FS 303 Chemical Weed Control in Trees. 1966. (Replaced by 358).
- FS 304 Weed Control in Sorghum. 1966. (Replaced by 337).
- FS 305 Weed Control in Corn. 1966. (Replaced by 339).
- FS 306 Control and Elimination of Field Bindweed. 1966.
- FS 307 A Pasture System For You. 1966. (Replaced by 631).
- FS 308 Grain Sorghum Production. 1966.
- FS 309 Stubble Mulching. 1966.
- FS 312 Emergency and Late Planted Crops. 1966.
- FS 316 Fertilizing Pasture and Hayland. (Replaced by 425).
- FS 325 Fertilizing Small Grain. 1966. (Replaced by 435).
- FS 326 Dutch Elm Disease. 1966. (Replaced by 330).
- FS 329 Field Crop Varieties. 1967. (Replaced by 382).
- FS 330 What a Community Can Do to Fight Dutch Elm Disease. 1967. (Replaced by 580).
- FS 334 Corn Production Guide. 1967. (Replaced by 393).
- FS 335 Small Grain Production Guide. 1967. (Replaced by 392).
- FS 336 Sorghum and Soybean Production Guide. 1967. (Replaced by 394).
- FS 337 Weed Control in Sorghum. 1967. (Replaced by 400).
- FS 338 Weed Control in Small Grains. 1967. (Replaced by 552).
- FS 339 Weed Control in Corn. 1967. (Replaced by 442).
- FS 342 Checking a Weed Sprayer. 1967.
- FS 346 Spring Wheat Production. 1967. (Replaced by 383).
- FS 347 Soybeans. 1967. (Replaced by 429).
- FS 348 Weed Control in Soybeans. 1967. (Replaced by 555).
- FS 353 Checking Small Plot Weed Spraying Equipment. 1967.
- FS 358 Chemical Weed Control in Trees. 1967. (Replaced by 414).
- FS 364 Control and Elimination of Quackgrass. 1967. (Replaced by 497).
- FS 375 Great Plains Conservation Program. 1967.
- FS 380 How to Improve Net Return Per Acre in Oats in South Dakota. 1967. (Discontinued).
- FS 382 Field Crop Varieties. 1968. (Replaced by 427).
- FS 383 Spring Wheat Production. 1968.
- FS 384 Oats Production in South Dakota. 1968.
- FS 392 Small Grain Production Guide. 1968 (Discontinued).
- FS 393 1968 Corn Production Guide. (Replaced by 447).
- FS 394 1968 Sorghum and Soybean Production Guide. (Replaced by 447).
- FS 400 Weed Control in Sorghum. 1968. (Replaced by 553).
- FS 410 Wild Oats. 1968. (Replaced by 496).
- FS 414 Chemical Weed Control in Trees. 1968, 1972.
- FS 419 Weed Control in Lawns and Other Turf. 1968.
- FS 422 Interseeding for Pasture and Range Management. 1968.
- FS 425 Fertilizing Pasture and Hayland. 1968.
- FS 426 Chemical Weed Control in Pasture, Range and Hayland. 1968.
- FS 427 Field Crop Varieties. 1969. (Replaced by 484).
- FS 429 Soybean Production. 1969.
- FS 432 Fertilizing Corn in South Dakota. 1969.
- FS 435 Fertilizing Small Grain. 1969. (Replaced by 677, 678, 679 and 680).
- FS 442 Weed Control in Corn. 1969. (Replaced by 554).
- FS 443 Chemical Weed Control in Crops--1969. (Replaced by 498).
- FS 447 Row Crop Production Guide. 1969. (Discontinued).
- FS 448 Control and Elimination of Noxious Weeds. 1969.
- FS 449 Control and Elimination of Leafy Spurge. 1969.
- FS 450 Thistles: Control and Elimination. 1969.

- FS 456 Nature of Panspots and Their Improvement in Range. 1969.
- FS 484 Field Crops Varieties. 1970. (Replaced by 524).
- FS 485 Barley Production in South Dakota. 1970.
- FS 488 Flax Production in South Dakota. 1970.
- FS 493 Farmable Terraces. 1970.
- FS 496 Wild Oats. 1970.
- FS 497 Control and Elimination of Quackgrass. 1970.
- FS 498 Chemical Weed Control in Crops. 1970. (Replaced by 525).
- FS 501 One-Way Disc Plow. 1970.
- FS 503 Planting Tame Pastures and Hayland. 1970.
- FS 522 New Corn Maturity Rating (GDD).
- FS 523 Planting Corn in South Dakota. 1971.
- FS 524 Field Crop Varieties. 1971. (Revised annually).
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- FS 525B Chemical Weed Control in Soybeans. 1971. (Revised annually).
- FS 525C Chemical Weed Control in Corn. 1971. (Revised annually).
- FS 525D Chemical Weed Control in Sorghum. 1971. (Revised annually).
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- FS 652 Weed Control in Sunflowers. 1975.
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- FS 677 Fertilizing Wheat. 1978.
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- FS 679 Fertilizing Barley. 1978.
- FS 680 Fertilizing Flax. 1978.
- FS 692 Set Aside Acres. 1978.
- FS 702 Manure Use in Cropping. 1978.
- FS 703 Reduced Tillage. 1978.
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- FS 748 Fertilizing Soybeans. 1979.
- FS 752 Nitrogen Management. 1980.
- FS 754 Barley Proteins. 1980.

SCIENTIFIC PUBLICATIONS

Many scientists in the Agronomy, Plant Pathology and Plant Science Departments reported results of their research in papers presented at professional society meetings or published in professional journals. A partial list is included here. Omitted are papers presented at state meetings or written in newsletters and state publications such as Farm and Home Report, Soil Survey Reports, Proceedings of South Dakota Academy of Science and others. Also missing are papers from projects in which staff members did not respond to a request for a list of papers.

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